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FOREST ORGANIZATION FOR BEGINNERS.

(Continued from page 555, Vol. XI.)

SECTION III—ASSESSMENT—*(continued)*.

DESCRIPTION OF GROUPS.

HAVING separated the groups by means already described in Chapter III., the next step to be taken is the description of each one and of the conditions of station peculiar to each compartment, operations which are not inaptly termed by French Foresters "taking the inventory of the forest."

The points to be noted are (1) the species, (2) their modes of treatment, (3) cover, (4) density, (5) cubic contents, (6) increment, (7) age, (8) station.

The particulars of the investigation should be formulated in a book in statements, of which the form on next page may serve as an example.

(1). THE SPECIES.

A group may consist of one or more species. In the former case, it is said to be *unmixed;* in the latter, *mixed.*

For mixed groups, the relative proportion of each species should be given approximately, and the prevailing species mentioned first. The manner in which they are mixed should also be stated whenever it can be ascertained. Thus, a certain group may consist of ·7 Xylia, naturally regenerated, and ·3 teak, planted in lines.

(2). MODES OF TREATMENT.

These are fully discussed in books on sylviculture. The following is an outline of the principal systems, of which all others are modifications :—

Particulars of groups in the first series of the Nandi beat of the Kodali Range, Pundra Division, in 1886.

COMPARTMENT No. 1.

Locality.	Sub-compartment.	Area, acres.	Species.	*Age.* Years.	*Age.* Class.	*Quality.* Station.	*Quality.* Group.	Leaf cover.	Density.	Description of Station.	*Cubic contents, feet.* Per acre fully stocked.	*Cubic contents, feet.* Per sub-compartment.	Remarks and suggestions for future management.
Belmal, ..	*a*,	5·51	·6 Tk., ·4 Ter.,	45-55	III.	·2	III. Tk., I. Ter.	·6	·6	Formation gneiss, soil shallow, very light loam, with slight layer of humus under Xylia; other parts covered with a growth of low grass: gentle slope inclining to the N. E.	..	10,414	*Abbreviations.*—*Tk.*, teak: *Ter.*, *Terminalia tomentosa*: *Xy.*, *Xylia dolabriformis.* (*a*). Naturally grown group, situation unsuited to teak, getting very open, broadcast sowing of bamboo for ground cover desirable.
	b,	20·11	Xylia, ..	50	III.	·8	IV.	·9	·9		4,050	73,301	(*b*). Good, vigorous growth, humus covering to soil: requires thinning lightly in parts.
	c,	10·57	Waste, ..	..	..	·8	..	..	..		..	..	(*c*). Abandoned field, 10 years fallow: plant up, in combination with a crop of grain, with bamboo, and Xylia with ·5 of teak. Water close to in nullah. Rank growth of grass.
	d,	5·50	·5 Tk., ·5 Xy.,	90-100	V.	·6	I. Tk., III. Xy.	·4	·4		2,420	5,324	(*d*). Growth very bad, should be cut away, and planted up in the same manner as (*c*), water close to in nullah. Long grass.
	e,	7·57	·5 Tk., ·5 Ter.,	15	I.	·8	IV. Tk., III. Ter.	1·0	1·0		..	..	(*e*). Alternate rows of teak and Terminalia planted at 5 feet distances. Growth good.
Total, ..	..	44·26											

I. Seedling-Forest, which has been raised directly from seed.

II. Coppice, which is the result of shoots from the stumps, stems, or roots of trees.

III. Overwood, also called *coppice with standards, stored coppice*, which is a combination of seedling-forest and coppice.

Seedling-Forest is treated—

(1). By the Primitive Method, or *method of selection*, when each tree in a forest is cut out as soon as it becomes exploitable, without reference to other trees.

(2). By the Method of Regular Cuttings, when coupes are confined to comparatively small areas, on which all trees are cut at the same time, or nearly the same time, and the area, thus cleared, re-stocked artificially or naturally.

Regular cuttings may be divided into—

(*a*). Clean Cuttings, when all trees on a given area are cut away clean, and the forest regenerated artificially or naturally.

(*b*). Natural Regeneration Cuttings, when the trees are only gradually removed, so as to effect the regeneration of the forest by seed in the natural way, and to afford protection for a time to the young growth.

Coppice-Treatment is similar to the treatment of seedling-forest subject to clean cuttings, with the sole difference that reproduction is differently effected, namely, by the shoots that *spring from the stools or roots.*

The form as well as the kind of treatment should be noted. A group may have originated, for example, artificially from sowing or planting. In the latter case, the trees will have been planted at regular intervals, in lines, squares, clumps, &c.

(3). Leaf-Cover or Cover.

This term refers to the canopy of leaves of a tree, or group. When the sun's rays are unable to pierce the foliage of a group, or when all grass is entirely suppressed on account of the shade, the cover is said to be *full* or *complete.* Full cover is taken as the unit of comparison, and less degrees are expressed in decimals of it. Of course, this is a matter which can only be very roughly determined according to individual judgment, there being no means of ascertaining the exact degree of cover by measurement or calculation ; fortunately, a very rough estimate is all that is required for practical purposes, a knowledge of the amount of cover being chiefly useful to the organiser as an index to the general conditions of growth and environment. To illustrate my meaning, let us suppose that the cover of a young plantation consisting of unmixed teak is put down in the register as ·4, or less : even a stranger to the group would guess at once that its state was bad, with probably a rank growth of grass and an impoverished, dried-up soil, and that, if

it were a question of maintaining the group to an advanced age, it would be necessary to fill up gaps with soil-improving species. On the other hand, if the cover were shown in the register as ·9, he would know that the general conditions of vegetation were on the whole satisfactory, and form his plans accordingly.

(4). Density.

This term refers to the closeness and distribution of the trees in a group. When an area is fully-stocked, its density is complete and expressed by unity; if incompletely-stocked, the degree is expressed in decimals. The density of a group is very difficult to ascertain accurately. It may be determined simply by eye, the organiser walking through the group in several directions and determining the degree of density to the best of his ability, without making any measurements; or, where greater accuracy is considered necessary, he may roughly measure open spaces and deduct from the general result the ratio their area bears to the whole area. To put the matter in a more concrete form—if, after traversing a 100-acre group in several directions, we come to the conclusion that its general density, exclusive of blanks, is ·8, but that there are open spaces aggregating 20 acres, or ·2 of the whole area, the density of the group would only be $\cdot 8 - \cdot 2 = \cdot 6$.

The more accurate determination of the density, is of importance only in those cases (1) in which the yield of a group is to be determined by the mensuration of merely a portion of it, the contents of the whole group being deduced from the result; or, (2) when the contents of the whole group is taken, without any direct measurements, from experiential tables showing the already-ascertained contents per acre of groups of the same age and species growing under similar conditions. It may also be necessary, even though the cubic contents are not required to be known at all, (3) in those cases in which it is desirable to know the area of blanks which require filling up in young groups.

When parts of a compartment are bare or when the density of the standing-stock in them is less than ·1, they are called *blanks*. Large open spaces of several acres extent, are called *wastes*. When blanks and wastes are *permanently* bare from physical, or other causes, the fact should be noted.

(5). Cubic Contents.

Before describing the methods most frequently employed in determining the contents of standing-stock, it may be as well to mention that only a few systems of management necessitate the determination of the contents of every group, that is to say, only those in which the estimate of the yield is based on the estimated annual increment of the whole forest; whereas those systems—and they are mostly in vogue at the present time—which determine the quantity of material to be cut partly by

area and partly from the estimated quantity of standing-stock, generally only require the determination of the contents of groups which are approaching maturity.

The methods most frequently employed for determining the cubic contents of groups, or of trees in groups, will be found in the following synopsis :—

A.—INVOLVING DIAMETER-MEASUREMERTS OF ALL TREES.

I.—BY MEANS OF SIZE-CLASSES ONLY.

(1). By felling test-trees of one size only.
(2). By felling test-trees for each size-class.

II.—BY MEANS OF SIZE-CLASSES AND HEIGHT-CLASSES.

III.—BY MEANS OF FORM-COEFFICIENTS WITHOUT ANY FELLINGS.

B.—INVOLVING DIAMETER-MEASUREMENTS OF A PORTION OF THE TREES.

IV.—BY MEANS OF TEST-PLOTS.

C.—INVOLVING NO DIAMETER-MEASUREMENTS.

V.—BY EYE.

VI.—BY EXPERIENTIAL TABLES.

A.—METHODS INVOLVING DIAMETER-MEASUREMENTS OF ALL TREES.

I.—BY MEANS OF SIZE-CLASSES ONLY.

If, in a group, all trees were exactly of the same height and form, all that would have to be done, in order to ascertain accurately the quantity of standing-stock, would be to count the number of trees : fell one : calculate its cubic contents from its dimensions : and multiply the result thus obtained by the number of trees in the group. Unfortunately groups consisting of trees of uniform growth are never met with, and it is necessary to find out, and fell one of average size amongst a number of various forms. A tree used for this purpose is called a *test-tree*, or *average tree*, because it represents the average cubic contents of one tree of the whole group. In the following pages, the methods, just referred to, of determining the contents of groups by means of test-trees, will be described.

(1). *By felling test-trees of one size only.*

By this method, the trees of a group are divided into size-classes, according to their diameters, or circumferences, at breast-height (4½ feet). It is not possible for practical purposes to take into consideration minute differences of size. The calculation of basal areas—a term used to denote the area of the section of a tree taken at right angles to its length—would be too laborious if the area for every tree had to be made out separate-

ly; it is, therefore, usual to class together all trees of about the same basal areas, so that the calculation of one may serve for a number of others. Supposing, for example, we decide, when measuring a group, on putting into the same class all trees whose diameters do not exceed $20\frac{1}{2}$ inches, nor fall below $19\frac{1}{2}$ inches, and that we have 200 such trees, their average diameter would be assumed to be 20 inches, and all we would have to do, in order to calculate the sum of the basal areas of these 200 trees, would be to multiply the area of a circle of 20 inches' diameter by 200, a result which could be obtained, without any calculation, directly from tables constructed for the purpose. The basal areas of the remaining size-classes—$20\frac{1}{2}$ to $21\frac{1}{2}$, $21\frac{1}{2}$ to $22\frac{1}{2}$, and so on—would have to be estimated in the same manner, and the average diameter of a tree of the whole group deduced from the total sum by means which will be explained further on.

The reason why it is necessary to find the basal areas of all trees at $4\frac{1}{2}$ feet from the ground is this. What is required, is the diameter of a tree of *average* size; therefore, since the areas of circles vary as the squares of their diameters, it would not do simply to add up the diameters of all trees in a group, and divide the sum by the number of trees, taking the quotient as the average diameter.

All trees, then, are measured at $4\frac{1}{2}$ feet from the ground, and the diameter, or girth, of a tree of average basal area deduced from the result. Several trees of the diameter, or girth, thus obtained, are felled and measured, and their average cubic contents determined. The cubic contents of the whole class is then found by multiplying the average cubic contents of a test-tree by the number of trees in the group.

As already observed, all experience goes to show that the results obtained by diameter-measurements are, as a general rule, quite as accurate as those obtained from girth-measurements, and, at the same time, far more quickly accomplished. I will not, therefore, in future, allude to girths and girth-classes, but to diameters and diameter-classes, although there is no objection, so far as concerns the accuracy of the work, to the employment of the tape in preference to the diameter-measure.

In the field, the method of estimating the cubic contents of groups by means of test-trees of one size only may be carried out in the following manner:—

The range of each diameter-class must first be fixed. The smaller the range the more accurate will be the resulting basal areas. Supposing that a quarter of an inch is fixed as the common difference, then eighths of an inch would be neglected and rounded off to quarters. The classes would be $5\frac{7}{8}$—$6\frac{1}{8}$ inches, $6\frac{1}{8}$—$6\frac{3}{8}$, $6\frac{3}{8}$—$6\frac{5}{8}$, $6\frac{5}{8}$—$6\frac{7}{8}$, and so on.

The measurements may be carried out in the following manner:—Two or more workmen provided with diameter-measures

are drawn up in a line at a corner of the group to be measured and at right angles to one of the sides. Each one is accompanied by a man provided with a bark-blazer, or with a pot of paint and a brush. The bark-blazer (see figure) consists of a gouge-shaped steel cutter (*a*) an inch long, at the end of an arm (*b*) 4 inches long. This blazer is more handy than an axe, *and its use is to be preferred to colouring-matter*, which is apt to be washed away by rain. Behind the line stands a clerk, paper and pencil in hand, ready to note down the measurements of the front rank. The whole squad then moves in line from one end of the group to the other, the measurers measuring and calling out the kinds and diameters of the trees as they advance, and the markers, or blazers, marking with paint, or blazing, as the case may be, the trees measured, in order that they may not be measured twice by mistake. Sometimes the *measurers themselves mark the trees, when special markers are*, of course, not required. Arrived at the other end of the group, the squad wheels round and takes up a fresh plot of ground, proceeding in this way to and fro until the whole group has been examined. In very open forests of large trees, it will often suffice to mark only the trees on the edge of the line. To make sure that measurements are made at the proper height from the ground, a mark may be made on the chest of each measurer at the required height.

The Bark-Blazer.

The clerk notes down the results in the following form :—

Diameter, inches.	Teak.	Total.	Xylia.	Total.	Lagerstrœmia.	Total.	Remarks.
6–6¼	~~||||~~ ~~||||~~ ~~||||~~ ||| &c.	18	~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ || &c.	22	||| &c.	3	Three Terminalias were included under teak.
6¼–6½							
6½–6¾							
7							
&c.							

As soon as four trees of a class have been noted, the fifth is marked down by a dash across, thus : ~~||||~~. This mode facilitates adding up results. Sometimes simply dots are used instead of *strokes, and arranged in twenties, thus*

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.....  .....  .....
.....  .....  .....
.....  .....  .....
.....  .....  .....
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A far greater number can be got into the same space in this way. When the trees have been all measured and booked, the number in each class is added up.

The diameter of an average tree must then be determined.

Let $d_1, d_2, d_3, \ldots \ldots d_n$ represent the diameters of each class, respectively, $n_1, n_2, n_3, \ldots \ldots n_n$ the number of trees in each class, respectively, and $a_1, a_2, a_3, \ldots \ldots a_n$ the areas of circles of diameters $d_1, d_2, d_3, \ldots \ldots d_n$.* The average area ($a$) of all these circles will be found by the equation

$$a = \frac{n_1 a_1 + n_2 a_2 + \ldots \ldots + n_n a_n}{n_1 + n_2 + \ldots \ldots + n_n}$$

Here it is necessary to digress for a moment to explain the meaning of the term *co-efficient of form*. If trees were perfect cylinders, their contents would be determined by multiplying their basal areas by their heights. As is well known, the form of a tree is never that of a cylinder, and its contents will have to be found by multiplying the product of these two magnitudes by a constant which is called the *form-co-efficient*. If h is the height of a tree, a its basal area, f its co-efficient of form, c its cubic contents, then, evidently,

$$c = a \times h \times f \ \ldots\ldots\ldots\ldots\ldots\ldots \quad (1).$$

and

$$f = \frac{c}{a \times h} \ \ldots\ldots\ldots\ldots\ldots\ldots \quad (2).$$

The co-efficient may be for the whole tree (including branches), in which case it is called *tree*-co-efficient, or for the timber portion only, when it is called *timber*-co-efficient.

The cubic contents of n trees would be, by the above formula—

$$a \times h \times f \times n.$$

Therefore—to return to the formula for finding the average basal area of a number of trees of different diameters—their cubic contents will be

$$a_1 h_1 f_1 n_1 + a_2 h_2 f_2 n_2 + \ldots \ldots + a_n h_n f_n n_n$$

or, if $h_1 = h_2 = h_n = h$,

that is to say, if we assume that all trees are of the same height,

$$h\,(a_1 f_1 n_1 + a_2 f_2 n_2 + \ldots \ldots + a_n f_n n_n).$$

But the cubic contents of the group is also equal to the contents of the average-tree multiplied by the number of trees in the group.

$$\therefore\ h \,.\, a \,.\, f \,.\, (n_1 + n_2 + \ldots + n_n) = h\,(a_1 \,.\, f_1 \,.\, n_1 + a_2 f_2 n_2 + \ldots + a_n \,.\, f_n \,.\, n_n).$$

When h is the height, a the basal area, and f the co-efficient, of the average-tree.

If, now, we assume that the co-efficient of form is the same

* If the diameter (d) of a circle is given, its area is $\pi \left(\frac{d}{2}\right)^2 = \cdot 7854 \times d^2$.

throughout as the average one, f—which, considering that the trees are all supposed to be of about the same height, is not an improbable contingency—we get

$$a\,(n_1 + n_2 + \ldots + n_n) = (a_1\,n_1 + a_2\,n_2 + \ldots + a_n\,n_n)$$

and
$$a = \frac{a_1\,n_1 + a_2\,n_2 + \ldots + a_n\,n_n}{n_1 + n_2 + \ldots + n_n}$$

The area (a) of the circle corresponding to the average diameter being found by this formula, it is an easy matter to find the diameter corresponding to it. A number of trees of the same diameter are felled, the cubic contents of each determined, and the average taken as the contents of the test-tree. The number of trees in the group multiplied by the cubic contents of the test-tree gives the cubic contents of the group.

An example will make this, apparently complicated, but in reality extremely simple, procedure quite clear.

Supposing the trees of a group are measured and found to contain—

100 trees	of 10 in. diam. each;	with, therefore,	basal area	each of	·545	sq. ft.
200	,, 10½	,,	,,	,,	·601	,,
250	,, 11	,,	,,	,,	·660	,,
180	,, 11½	,,	,,	,,	·721	,,
200	,, 12	,,	,,	,,	·785	,,
140	,, 12½	,,	,,	,,	·852	,,
130	,, 13	,,	,,	,,	·922	,,

Inserting these values in the formula we get

$a = (100 \times \cdot545 + 200 \times \cdot601 + 250 \times \cdot660 + 180 \times \cdot721 + 200 \times \cdot785 + 140 \times \cdot852 + 130 \times \cdot922) \div (100 + 200 + 250 + 180 + 200 + 140 + 130) = 865\cdot62 \div 1200 = \cdot721$ sq. ft.

This corresponds to a diameter of 11·5 inches.*

A sufficient number of trees of the required diameter are then felled and measured. The boles are measured in lengths of not more than 10 feet. The diameter of the mid-section of each length is measured, and its contents found by multiplying the corresponding area of a circle by the length of the piece. Amorphous pieces, such as crooked branches and spray, may be stacked, and their contents deduced from results previously obtained for the cubic contents of stacked wood of the same description; or the contents may be calculated by the process described at p. 553 for the determination of the contents of amorphous wood. If more than one species occur in the group, each will have to be examined separately if largely represented.

(2). *Method of determining the contents of Groups by felling Test-trees for each Size-Class.*

The method just considered is evidently applicable only to the

* Calculations of this kind may be greatly shortened by using tables which give the sums of basal areas of stems of the same diameter, from 1 to 100 stems.

case of groups in which the trees are all of about the same height and diameter. Should this not be the case, it is advisable to treat each class separately, or at all events to limit the number of classes for which one test-tree is felled. It is usual to unite for this purpose 3 to 5 classes under one major class. The number thus united depends on the degree of irregularity of the group, and of accuracy required. Each major class is treated as if it were a group apart, the sum of the contents of the several major classes constituting the yield of the whole group.

Example.—Supposing it had been decided to convert the classes of the group, referred to in the last example, into two major-classes; the one comprising all trees of 10—11½ inches diameter, and the other those of 12—13.

There would then be for the former major class :—

100 trees	of 10 in. diam.	with a sum of basal areas of			54·5	sq. ft.
200	„ 10½	„	„	„	120·2	„
250	„ 11	„	„	„	155·0	„
180	„ 11½	„	„	„	129·78	„
730	trees with total basal area of	...	...	...	469·48	„

Therefore, the average basal area of one tree is $\frac{469 \cdot 48}{730} = \cdot 643$ square feet, which corresponds to a diameter of 11 inches. The diameter of the test-tree for the first major class is, therefore, 11 inches.

The second major class would consist of—

200 trees	of 12 in. diam.	with a total basal area of			157·00	sq. ft.
140	„ 12½	„	„	„	119·28	„
130	„ 13	„	„	„	119·86	„
470					396·14	„

And the average basal area of a tree for it would be $\frac{396 \cdot 14}{470} =$ ·843 square feet, which corresponds to a diameter of 12·5 inches.

If the averages of the test-trees felled contain, say, for the first class, 11·31 cubic feet, and for the second 12·9 cubic feet, then the contents of the whole group would be

$$730 \times 11 \cdot 31 + 470 \times 12 \cdot 9 = 14319 \cdot 3 \text{ cubic feet.}$$

In this example it is assumed that the group is unmixed. If it were mixed, it might be necessary to estimate the yield of each species separately.

It is advisable to fell a fixed percentage of test-trees of each major class: ½ to 1 per cent. will suffice for ordinary purposes. The latter rate, in the above example, would give seven test-trees for the first and five for the second. A larger relative

number is sometimes taken for classes comprising the larger trees.

In selecting test-trees, trees should be chosen which appear to be representative of their class as regards height and crown, and which have a circular (not elliptical) trunk. If a suitable tree of exactly the required diameter is not to be found, another of nearly the same diameter may be taken instead, and the cubic contents of a proper test-tree deduced from its volume.

In that case, if V is the volume and d the diameter of the proper test-tree, V' and d' the corresponding dimensions of the tree actually measured, V would be found by the proportion,

$$V : V' :: \frac{\pi}{4} d^2 h \cdot f \cdot : \frac{\pi}{4} d'^2 h' f'$$

When h, f, and h', f', represent the heights and form-coefficients of the trees, respectively. Since, however, their heights and co-efficients must be very nearly alike, h, f, may be put equal to h', f', when the proportion becomes

$$V : V' :: \frac{\pi}{4} d^2 : \frac{\pi}{4} d'^2$$

Whence
$$V : V' :: d^2 : d'^2$$

or
$$V : V' :: a : a'$$

when a and a' are the basal areas of the trees, respectively. Therefore,

$$V = V' \frac{d^2}{d'^2}$$

or
$$= V' \frac{a}{a'}$$

The details of the estimate may be tabulated in the following form :—

Particulars of Test-Trees.						Number of trees in each major class.	Particulars of Groups.		
Species.	Age.	Height to outermost branches. Feet.	Mean diameter. Inches.	Major class. Inches.	Cubic contents. Feet.		Cubic contents. $f \times g$ Feet.	Estimated percentage of Timber.	Estimated percentage of Other wood.
a	b	c	d	e	f	g	h	i	k
Teak	30	80	11	10-11½	11·50				
"	"	34	"	"	12·65				
"	"	28	"	"	10·59				
"	"	29	"	"	10·50				
			To	tal, ...	45·24				
Ave	rage	contents	of one	tree,	11·31	730	8256·3	85	15
"	"	31	12·5	12-13	13·02				
"	"	33	12·5	"	12·78				
					25·80				
Ave	rage	contents	of one	tree,	12·90	470	6063·0	85	15
and so on for the remaining classes.									

The percentage of timber and firewood is calculated on the average yield of the test-trees. For this reason, it is perhaps advisable to divide column *f* into two sections, the one showing the yield of timber, the other of firewood.

In order to avoid the necessity of estimating the trees of each class separately, the number of test-trees for a class may be made to bear a fixed proportion to the number of trees in such class.

Take, for example, a group consisting of the following trees :—

Diameter-class. Inches.	Number of trees.	Corresponding basal area of one tree. sq. ft.	Sum of basal areas $b \times c$. sq. ft.
a	*b*	*c*	*d*
10	100	·545	54·5
10½	200	·601	120·2
11	250	·661	165·0
11½	180	·721	129·78
12	200	·785	157·00
12½	140	·882	119·28
13	130	·992	119·86
	1200		865·62

If, now, we fell 1 per cent., we shall require altogether 12 test-trees, distributed among the classes as follows :—

For the class 10 inches $\frac{12 \times 100}{1200} = 1{\cdot}0$ test-tree

" 10½ " $\frac{12 \times 200}{1200} = 2{\cdot}0$ "

" 11 " $\frac{12 \times 250}{1200} = 2{\cdot}5$ "

" 11½ " $\frac{12 \times 180}{1200} = 1{\cdot}8$ "

" 12 " $\frac{12 \times 200}{1200} = 2{\cdot}0$ "

" 12½ " $\frac{12 \times 140}{1200} = 1{\cdot}4$ "

" 13 " $\frac{12 \times 130}{1200} = 1{\cdot}3$ "

As we cannot examine fractions of test-trees, it is necessary to round off these figures, a procedure which will make no practical difference in the general result. We shall then get

For 10-inch class		...	...	1	test-tree
$10\frac{1}{2}$	"	...	...	...	2	"
11	"	...	...	...	3	"
$11\frac{1}{2}$	"	...	...	...	2	"
12	"	...	...	...	2	"
$12\frac{1}{2}$	"	...	...	...	1	"
13	"	...	...	...	1	"
					12	

If we had not already the full complement of trees, we might, by forming the $12\frac{1}{2}$ and 13-inch classes into one class, have made these classes together amount to 2·7, which, when rounded off, would have given three trees for these two classes instead of only two. Having, however, got the full number without doing this, it is better not to increase the number, but it is always advisable to resort to this device for completing the percentage whenever it can be conveniently accomplished.

Having determined the diameters of the test-trees, in the manner already described, and selected corresponding trees in the group, we may determine their cubic contents, either by measuring them separately for each major-class, or all together. In the latter case, the portions of the trees which are disposed of in stacks are worked up all together into stacks, and then measured.

The particulars of the estimate and measurements are then noted down in the following form :—

PARTICULARS OF TEST-TREES.

Serial No.	Diameter-class.	Number of trees.	Basal area of one tree.	Sum of basal areas c × d.	Height.	Age.	Contents. Timber.	Firewood.	Total h + i.
	Inches.		Sq. ft.	Sq. ft.	Feet.		Cubic ft.	Cubic ft.	Cubic ft.
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*k*
1	10	1	·545	·545	30	30	9·87	1·63	11·50
2	$10\frac{1}{2}$	2	·601	1·202	34	"	21·50	3·80	25·30
3	11	3	·660	1·980	28	"	27·03	4·77	31·80
4	$11\frac{1}{2}$	2	·721	1·442	29	"	17·84	3·16	21·00
5	12	2	·785	1·570	31	"	22·10	3·90	26·00
6	$12\frac{1}{2}$	1	·882	·882	33	"	10·88	1·92	12·80
7	13	1	·922	·922	35	"	14·60	2·40	17·00
				8·543			123·82	21·58	145·40

To find the contents of the group, let M represent its cubic contents, m that of the test-trees, A the sum of the basal areas of all trees in the group, a that of the test-trees. We shall then

have the proportion

$$M : m :: A : a$$

and, therefore $$M = \frac{A}{a} m$$

In the present case

$$A = 865{\cdot}62 \;;\; a = 8{\cdot}543 \;;\; m = 145{\cdot}4.$$

Therefore $$M = \frac{865{\cdot}62}{8{\cdot}543} \times 145{\cdot}4 = 14784{\cdot}6$$

or, if we wish to find the timber and firewood separately, the timber alone will amount to

$$\frac{865{\cdot}62}{8{\cdot}543} \times 123{\cdot}82 = 12590{\cdot}3$$

and the firewood to

$$\frac{865{\cdot}62}{8{\cdot}543} \times 21{\cdot}58 = 2194{\cdot}3$$

One of the chief merits of this method, which was invented by a German of the name of Draudt, is that those portions of the test-trees which are sold in stacks can *be all worked up together* into stacks, whose contents may then be deduced from known results of the solid contents of stacked wood. When the contents of the fellings of each major-class have to be calculated separately, as is the case when the percentage varies, there will seldom be enough material in each single major-class to make good-sized stacks of the several descriptions of amorphous wood, and the laborious process of indirect measurement, described at page 553 will have to be resorted to; whereas, when there are a number of test-trees, it will generally be possible by Draudt's method to get a sufficient quantity of stacked material of every description to make reliable quantitative deductions from previous experiments. Stacking the wood and deducing its solid contents from known results, is generally preferable to deducing the number of stacks from the solid contents of the wood, because, in the latter case, if the stack-coefficients are not accurately determined, the number of stacks actually obtainable from a group will not tally with the estimated number; but the two will correspond if the converse method is followed, provided, of course, that the test-trees represent the proper relative quantity of wood.

A further advantage of Draudt's method is, that it shows the relative proportion of wood of all descriptions of a group, a factor on which the value of forests greatly depends. It is often not so much on quantity as on quality that the value of wood in a group depends; and it is, therefore, important in very valuable forest to fix the quantity of each description as accurately as possible.

Draudt's method may be advantageously employed for all systems of estimating the cubic contents of groups which require the felling of test-trees, and the diameter-measurements of all trees on the area examined.

(*To be continued.*)

LIGHT GRAZING IN FORESTS IN THE STAGE OF REPRODUCTION.*

In February last a letter was circulated by the Government of India on light grazing in the Berar State reserves. The letter was written by Mr. Drysdale, Conservator of Forests of the Hyderabad Assigned Districts, and involves questions and contains statements which, if left unchallenged in the pages of a professional paper, may prove a danger to forest conservancy throughout India. The letter contains much which is seductive to the general civil administration of the country, which naturally grasps at everything that promises a diminution of the restrictions incidentally imposed on the people by the necessities of forest conservancy.

Such desire is entirely justifiable, and should as far as feasible be shown by every officer of the Forest Department, but it behoves us to sift the matter from a professional point of view.

This is all the more necessary, as the Government of India letter already indicates a desire of generalizing on Mr. Drysdale's palatable conclusions, based on observations which locally and for the time being may perhaps be true, but which we must nevertheless accept with the greatest caution.

Mr. Drysdale states that, according to his observations, a forest in the state of reproduction does not suffer by light grazing, nay—that light grazing improves and encourages the growth of seedlings; and he recommends that the whole of the Berar forests should be treated in this manner, and be opened to light grazing. There we have got a revolution,—all that has been taught us in Forest Schools and books must have been wrong, all our observations collected during many years spent in the Indian forests must have been faulty. If not, those of Mr. Drysdale are inaccurate and incomplete, or his conclusions are based on insufficient ground. We are quite aware that there may be exceptional circumstances where not only light grazing but severe grazing is not only admissible but advisable in a forest under reproduction, for instance when the young growth is scanty, and an exceptional good seed year is expected. Under such circumstances the driving in of cattle, pigs in preference, is sometimes resorted to, to open and wound the ground, but is stopped soon after the seed begins to fall. Young pine reproduction is also sometimes cleared from excessive grass growth by a periodical driving through of sheep. That much good can under special circumstances be done by the destruction of weeds, the opening out of undergrowth, and the wounding of the soil for the reception of seed is acknowledged, also that this can to a certain extent be effected by the driving

* Our pages are open to any arguments which may be adduced on both sides of this question.—[Ed.]

in of cattle, but that reproduction can be improved by continued light grazing is false, and is, moreover, not proved by Mr. Drysdale. The fact that continuous grazing of cattle is prejudicial to reproduction in a forest cannot be upset by a few casual observations and rashly drawn conclusions. We are prepared to admit that Mr. Drysdale observed in the forests visited by him a large number of seedlings which escaped being killed by cattle, as well as a great deal of standing grass; but that less seedlings were in existence in a closed forest on the same area, equally situated and with the same number and class of parent trees, we venture to doubt in the absence of more detailed information than is vouchsafed in the few paragraphs which dispose of this important subject. Granted that a large number of seedlings were found on the areas subjected to light grazing, no other information is forthcoming by which the correctness of the conclusions derived at could be tested. On the other hand, as Mr. Drysdale compares the grazed area with closed forests, the inference lies near that the areas to which he refers were previously fire protected and closed against grazing. This being the case, the grass crop was presumably more than ordinarily dense, and must have contained a great deal of dead standing grass, which cattle, unless reduced to starvation, would not eat. A great deal of the good grass would also be protected by the dead grass blades mixed with it. The careful way in which, under ordinary circumstances, cattle will avoid mouthing this dead grass is known to every observing forester, and it is, therefore, hardly a matter for surprise that the effect of the first year's grazing was not very appreciable as regards the grass crop. In respect to the number of seedlings found on the ground, it is not stated whether the remark applied correctly to the whole area in which grazing was allowed, for cattle do not graze over an entire area equally unless by scarcity they are reduced to eating up everything; nor is it said whether in the areas strictly closed the same facilities for the supply of seed existed.

It would also be most important had it been noted whether the seedlings observed were of the year in which the cattle were permitted to graze, or the result of previous year's seedlings. This is perhaps the most important information that is wanting, for it is more than likely that in the strictly protected area a very large proportion of the seedlings escaped observation in the dense grass crop, which they would penetrate in course of time. Much stress has been laid on the advantage which seedlings have derived from the thinning of the grass by cattle; and no doubt the remaining seedlings are more conspicuous, but whether any real advantage exists in their exposure is more than problematical. Let us consider what takes place in a forest of the usual open character of most of our Indian forests when strictly closed by fire protection.

By the addition of new blades to the dead grass of the previous year, the density is increased till further production becomes impossible. Then the crop falls to the ground, causing open spaces here and there covered by dead grass, which soon decomposes and permits, if seed bearers are in existence, the springing up of a rapid and complete reproduction of arborescent growth. Numerous seedlings have in the meantime sprung up in the standing grass, which at this period begin to show above the dead grass. The young forest is kept moist by the dead grass round their roots, and a large portion of the seedlings are fairly established before the grass crop can again gain the ascendant. That a certain number of seedlings are choked in this process is certainly true, but accurate observation shows, that their number is much smaller than is usually supposed. Moreover, the drying down of the grass repeats itself at no very long intervals. Any interference with this natural process, even grass cutting, tends to check natural reproduction, though the mere cutting of grass but rarely forms an obstacle to true conservancy.

Mr. Drysdale states that he found a large number of seedlings in the grazed area, but, as already pointed out, does not mention what percentage of these belonged to the pre-opened era.

We will, however, accept that a large number belonged to the year in which grazing was first permitted, for it is undoubtedly a fact that in fire protected areas, even with grazing, a considerable amount of reproduction takes place, though the proportion of seedlings which survive the first four months of their existence is extremely small, and these, any accurate observer will agree, mostly owe their preservation to some accident, either they germinated between stones, or near a root or thorny shrub, or near dead grass, which the cattle did not approach. A previously fire protected and closed forest would consequently offer, during the first year or two, numerous means of escape, which in the present case helps no doubt to account for the large number of seedlings observed. This favourable appearance of the reproduction will doubtlessly disappear with a continuance of light grazing.

The fact remains that continued grazing is hurtful to forest reproduction, and the damage done is only a question of degree. It is estimated that the hoof prints of a grazing animal will cover $1\frac{1}{2}$ acre during one grazing season. It is evident that the more herds congregate, and the smaller the areas are in proportion to such herds, the more often will the cattle place their feet on the same spot, and the fewer plants will actually be trodden down by them. It seems, therefore, clear that when grazing requirements have to be met beyond the grazing in forests, where a complete young growth has outgrown the danger from being damaged by cattle, or in compartments which

are not otherwise in the stage of reproduction, it is infinitely preferable to give up for the time being certain fixed areas for grazing purposes, until other portions of the forests in which reproduction is in the meantime completed, and in which the young growth has outgrown the danger from cattle can be opened in turn. It goes without saying that areas open to grazing should enjoy full rest in every other respects.

Without ensuring rapid and complete reproduction by strict periodical closure, all hopes of our introducing any regularity in rotation is utterly futile.

The number of seedlings eaten by the same number of cattle, or pulled out with the grass, or destroyed either willfully or to keep off insects is probably the same whether light grazing over large areas or periodical severe grazing is resorted to.

Another argument which can be brought against light grazing over large areas is that, of all the wasteful methods of reaping a grass crop, it is the most wasteful, as the grass is rendered unfit for cutting over an unnecessary large extent of country. It leaves no reserve to fall back upon in times of scarcity.

As already said, the damage done by grazing is always a question of degree, and of course grazing might be so excessively light as to render the damage inappreciable, but under these circumstances the apparent benefit conferred on the people would also be of little or no importance.

TOPS.

RÁB IN THANA.

THE question of "ráb" from an agricultural point of view has been treated in several lengthy articles in the "Indian Agriculturist" by the Director of Agriculture, Bombay, but I think there is room for a few words on the subject from the standpoint of forests. First, then, what is ráb? Ráb primarily and strictly means the "nursery bed" in a system of cultivation in which the young plants are raised in seed beds and then transplanted. But these nursery beds are almost universally prepared by burning upon them either cow-dung, grass, leaves, tree loppings or several of these. Hence ráb has come to mean the material so burnt, and is commonly so understood. There is still, however, another and more limited meaning, *viz.*, "tree loppings." The fact is that ráb is only brought into prominent notice by the demand for tree loppings from forest, hence gradually in official language ráb has come to be synonymous with tree loppings. In Thana, a district with a very heavy rainfall ranging from 100 to 200 inches, and situated between the Jyhadri ghat range and the sea, the staple crop is rice. Native agricultural opinion declares positively that (except in salt lands) rice cannot be grown without ráb, and this opinion

has been generally recognized as sound, but beyond this point there is no longer unanimity. Why is ráb necessary? What is the best ráb? Is "tree" ráb a necessity in Thana? These and many other questions are asked and answered in many different ways. Ráb is said by some to be required for its manurial value, by others this value is almost denied, and it is said to act by *killing* the weeds, and thus allowing the young seedlings to get a start. Personally I have no doubt that the rôle of ráb is, by its manurial value, both directly in the form of ashes and indirectly by calcining the soil, to force forward the seedlings in the nursery, and thus allow the cultivator to obtain a crop within the limited period of the rains (*viz.*, from July to October) which he could not do otherwise. That the weeds are kept down in the seed bed is true enough, but this is quite as much (if not more) owing to their being choked out by the luxuriant growth of the rice induced by the manure as it is to the destruction of the seeds of the weeds by the fire. This I think has been *clearly demonstrated by experiments made by Mr. S. Cook, of the* Poona College of Science, with his patent manure. "Nachni" has been grown in two plots, one prepared with ráb, and the other treated only with manure. The plants in the latter came up too thick and strong to allow the weeds a chance, while in the former, though generally dominated by the "nachni," they were nevertheless present, and in the blanks asserted themselves. What then is the best ráb? About this there is and can be no doubt, it is cow-dung. But next best it is urged is "tree ráb," and then far behind comes grass and leaves. This is the native theory, and they even distinguish between trees, placing ain (*Terminalia tomentosa*) first and the rest nowhere. Unfortunately no reliable experiments have been completed to settle the question, but the reason for the high value set on ain is plain enough. The loppings are stacked in small heaps and removed to the ráb-plot when dry and light to carry, consequently, that tree yields the best ráb whose leaves adhere longest to the twigs, and this is a special property of the ain. Apart from this it seems to me impossible that leaves, and still more loppings of brushwood, should be in any way inferior to tree loppings. The cultivators affirm that what they *desiderate is a hot but slow burning fire, and that hence the* high value of cow-dung. To obtain this with loppings they cover them with a layer of grass, and then with a thin layer of earth, and I believe that by employing several alternate layers of grass and earth the same result might be obtained. So much for ráb in general. I will now look at the ráb question as found in Thana in its relation to forests. The first point is the supply of cow-dung. The cattle are not fed at home in order to husband it, but free grazing in forest is demanded. During the rains and cold weather the cattle do not go much into forest, there being far better grazing in the open country, but during the rains the dung is lost as far as ráb is concerned owing to the

heavy rainfall, and the dung is consequently only collected during the months of November, December and January, after which the cattle spread over and wander in forest, and thus three-fourths of the total available supply is wasted. The supply of grass is lost because it is cut in large quantities and exported to Bombay for sale. Finally there is the supply of tree ráb. This is a longer question. In about half the district the tree growth in *occupancy holdings was at the survey retained as* Government property, and here the pinch is less felt, but in the remainder the rice lands having been accurately surveyed, a portion of the remainder was broken up into what was known as "warkas" numbers, and were given out free of assessment to holders of rice lands. No restrictions were imposed, in the mistaken idea that self-interest would cause the occupants to husband this source of ráb supply. What has been the result? In a large number of cases the occupancy right in the rice land has been sold, while the warkas attached to it has been retained. So that ryots may be *found who hold and cultivate several* acres of warkas *free of assessment*. The process has been simple. The trees on the warkas number have been cut down and sold to a dealer for export to Bombay as firewood, and then the land has been brought under cultivation for what are now known as "warkas" crops, *i.e.*, nachni, wari, &c., which however require ráb equally or more than rice. So that not only have the rice and its ráb reserve of warkas been divorced, forcing the rice land to seek elsewhere for ráb, but the warkas itself has changed from a ráb-supplying to a ráb-demanding area. Whence then is this *trebled demand for ráb to be met?* The unanimous popular outcry is "from forest." The equally unanimous opinion of all who have enquired into the matter is that this is impossible if forests are to exist. In one range the experiment has been tried by a demarcation officer; he has once more set apart an area from forest, in his opinion sufficient to meet the demand, so that the forest area now consists chiefly of perpendicular scarps and hill tops of almost bare rock, and *the people are not satisfied*. The area has been broken up and parcelled out, but there are thousands of cultivators in villages in which there is *no forest; what are they to do?* In fact we are now within measurable distance of the time (should the policy of granting tree ráb from forest be persevered in) when there will be no longer any forest left to fall back upon. The native agitators for the grant of permission to lop trees in forest maintain that it improves the trees, and they have been backed by more than one official dabbler in the forest question, but writing as I am for Foresters, it is needless for me to adduce proofs that the annual lopping of a tree not only cannot improve it, but *must* cause it to die (a deformed monstrosity weary of life) before its *time*. *Mr. Ribbentrop, I believe,* when the position was lately explained to him, expressed an emphatic opinion that tree lopping

in forest must cease, or the forests would disappear. A Conservator of many year's service and great experience, whom it was my painful duty to introduce to the ráb fiend for the first time, was dumb-founded, and expressed the same opinion as the Inspector General. The same opinion has always been held by every one I have met who has *thoroughly* and *honestly* studied the question.

What is to be done then about tree-lopping for ráb in the Thana forests? That is the question the Forest Commission has to answer. Will it recommend Government to temporarily still the popular outcry by grant of the permission to lop (under few or many restrictions is merely advancing or delaying the end a few years), or will it recommend that the system be at once put a stop to, and what remains of the forests rescued. Let us hope the latter. The outcry will be loud possibly, but it will be nothing compared to that which will be raised 20, 30 or 50 years hence, when the forests have been exhausted, but unfortunately *its distance in the future makes it sound like a mere whisper* now. I must apologize for the great length of this letter, but this is a busy time of the year, and I cannot spare leisure to condense and yet feel bound to ask for the good wishes and sympathies of all brother Foresters in view of the pending trial in which our forests are at stake.

GHATI.

TEA BLIGHTS.

" MESSRS. LLOYD and Co., Managing Agents, Chenga Tea Company, Limited, addressed the following letter to the Agricultural and Horticultural Society of India on this subject:—

" A short time back we handed you specimens of mosquito blight and blighted leaf sent down by our Manager, and in continuation we beg to place before you the following remarks, which form part of his monthly report:—

" ' Mosquito blight has spread all over the cultivation on the Factory and Bungalow side, as well as that portion called ' Junglukatu,' so that the yield of leaf was considerably lessened by it. Specimens of *the fly and blighted leaf were forwarded to Calcutta for Managing* Agents' inspection and satisfaction to show damage done. I have every reason for believing the species of tún (*Cedrela Túna*) trees planted along the roads of the garden are the great harbingers of this pest, for I have noted both in the hills and here these trees are always more or less blighted the whole year round, and the tea bushes under them and near by are always the first to be attacked, wherever tún trees are on the garden, the blight is worst, so that I would recommend every tree being cut down, as they are perfectly useless and valueless—all leaves and small branches to be burnt, the stems or trunks can be used for engine wood.'

" This is the first time that we have heard the presence of this pest attributed to the growth of tún wood trees adjacent to the tea.

Can you inform us whether you have any record supporting Mr. Helps' theory.'"

"The observations here recorded are of great importance, and further correspondence on the subject is invited."

The above extract from the minutes of a meeting of the Agricultural and Horticultural Society of India, held on 28th October, 1885, bring to notice some new suggestions with respect to the life history of those interesting insects, the Aphides or Plant Lice.

Cultivators of all kinds, from the Gardener to the Farmer, have always had to deplore serious losses due to the wholesale appearance of plant lice on their crops, but it is only comparatively lately that it has been thought necessary to study the habits of the insects. It has long been known—indeed, it is a fact which forces itself on the notice—that plant lice multiply at a pace which is simply prodigious. But it was only after some of the first scientific men of the day had given the subject their attention that the mystery was satisfactorily explained. In the autumn winged males and females pair, and the latter lay eggs, which pass through the winter to hatch in the following spring. From the eggs emerge nothing but females, and these females, unlike their parents, are wingless. At this season of the year not a male is to be found, but nevertheless the females continue to breed. A few days after the insects have left the egg, the germs of young ones begin to develop within them, and the dark eyes of the unborn young are clearly discernible with a microscope through the semi-transparent body of the mother. After a period of something less than a fortnight the young are born. No egg is laid, but the infant aphis comes to the light in the same shape as its parent, differing from it simply in point of size. Four or five young ones are generally born together, and these only require a very short time to develop, before they again begin to grow internal germs, and the process, known as *parthenogenesis*, is renewed. This sort of thing goes on until the autumn, when the last brood consists of winged males and females and the whole cycle is complete. The parthenogenetic reproduction has never been satisfactorily explained physiologically, though numerous theories have been put forward, but it has been observed that this sort of reproduction continues, so long as the weather is warm and succulent vegetable food abundant. Supplying the aphides with plenty of food and keeping them continually in a temperature of not less than 70° F., the parthenogenetic reproduction has been artificially prolonged to as much as four years without any apparent diminution of strength in the stock of insects. It is a point worth studying whether in Assam, where the conditions of temperature and food must be so peculiarly adapted for plant lice, there are any males at all. It is quite possible that the species may have originally spread from some less favourable

spot where males did occasionally appear. It may be just this peculiarity of parthenogenetic generation which underlies the whole question. In consequence of their method of development, the aphides may multiply so vastly that they cannot find on the tún trees alone, sufficient nourishment to supply the needs of their daily increasing hordes. Under these circumstances they are perhaps forced to have recourse to the tea bushes, though they would have preferred the tún, had there been enough of it.

Analogous cases to this are not wanting in other orders of the insect class. The caterpillars of *Gastropacha pini*, a moth well known and dreaded by German foresters, normally feed on the Scotch Fir (*Pinus sylvestris*), but when the supply of this food falls short, they do not hesitate to attack all kinds of other trees, and even spread on to cultivated crops. There is much less difference between tún and tea than between the resinous needles of Scotch Fir and the broad leaves of Angiosperms.

M. H. C.

23rd November, 1885.

DEHRA DUN FOREST SCHOOL.

THE session for theoretical instruction at the Dehra Dun Forest School was closed at the end of October, and the senior students of the Ranger's class then accompanied Mr. Fernandez, the Deputy Director, to the Kheri forests in Oudh, where the instruction in forestry was completed by a short course of forest organization. As a result of the final examination the following nine students have obtained the Ranger's certificate, and it is hoped to publish the names of the prize holders in the next number of the *Indian Forester*. The names are now given in alphabetical order:—

Atma Ram,	...	Punjab.
Devi Ditta,	...	Punjab.
C. P. Howell,	...	Madras.
Keshva Nand,	...	School Circle, N.-W. Provinces.
Nand Mal,	...	Ajmere.
C. M. Pillé,	...	Madras.
K. Ponnappah,	...	Coorg.
Sundar Das,	...	Punjab.
C. L. Toussaint,	...	Madras.

Two students, Gour Krishna Sirkar, Bengal, and Har Swarúp, School Circle, N.-W. Provinces, failed to qualify for the Ranger's certificate, but have obtained the Forester's certificate, and have returned to their own Circles. Moung Khan Hein of the Pegu Circle, who also failed in getting the Ranger's certificate,

will be kept at the School till the end of January to qualify in Surveying. Permeshri Din of the Oudh Circle, will stay another year at the Forest School to qualify for the Ranger's certificate.

All the students who have obtained the Ranger's certificate will continue to work in the Kheri forests until the middle of March at railway sleeper and forest valuation works, the latter being under Mr. A. F. Broun, and will then return to their own Circles.

This is the first batch of students leaving the Forest School who have passed through a complete course, under the new system, in which forestry is taught practically in the forests by Mr. Fernandez, instead of by the Divisional Forest officers of the School Circle, whose own executive duties do not permit of the instruction they were able to offer the students being sufficiently thorough.

The Junior Ranger's Class was also examined in the first year's subjects, and 29 students will go on to the second year's course, whilst five students will attend the first year's course again, and five students will return to their Circles after completion of the survey course, as they are not considered competent to follow the classes with advantage.

The Junior Students of the Ranger's Class, as well as the Vernacular Class 10 students, are now all employed in surveying in the Kalesar forests in the Phillour Division of the Punjab, under the superintendence of Mr. J. Copeland, and on completion of this work, will attend the forestry course under Mr. Fernandez, in the forests of the School Circle.

The Junior Ranger's Class is the largest which has yet attended the School, and comprises men of the following Provinces and States :—

Madras, ...	8
Bengal, ...	3
N.-W. Provinces and Oudh, ...	4
Punjab,...	7
Central Provinces, ...	2
British Burmah, ...	1
Coorg, ...	1
Mysore, ...	3
Baroda, ...	2
Jeypore, ...	4
Private students, ...	4
Total, ...	39

There are also five students on probation in the forests of the School Circle who will attend the course from next July. Of these one belongs to the School Circle, N.-W. Provinces, two are from Rewah and two from Partabgarh.

At the termination of the theoretical course at Dehra, the school athletics were held, and E. M. Buchanan, a student of British Burmah, won the long jump (17 feet), the high jump (5 feet 2½ inches), and the cricket ball (93 yards), whilst T. Hearsey, private student, won the hundred yards and hurdle race, and Ponnappah, from Coorg, won the long race round half the parade ground, distance about ¾ mile. The other events comprised a tug of war between the students of the first and second years, easily won by the former, the sack race, won by Sita Ram of Mysore, and a consolation race (100 yards) won by Mangal Sein of the Punjab. There was also a 200 yards race for the Sepoys of the 2nd P. W. O. Ghoorkha Regiment, in which 30 men competed in full marching order, and fired 10 rounds of blank cartridge as well as cleared three flights of hurdles.

THE FOREST SCHOOL OF NANCY.

THE attack lately made on the Nancy Forest School has of course considerably agitated the officers of the French Forest Department, of which the large majority have passed through that comparatively ancient institution. In the November Number of the *Revue des Eaux et Forêts* there are two letters discussing the question. The idea is to do away with the Forest School at Nancy, and attach the students to the Agricultural Institute at Paris. The correspondent, Marcel Taillis, argues for this move on the ground that the officers turned out would be better instructed, and that the expenditure, both by the State and the students themselves, would be reduced. On the first point he scarcely touches at all, and appears to take for granted as undoubted a hypothesis that most intelligent men would consider unsustainable, and perhaps he did not feel very happy on this head. As matters have hitherto stood, the students have passed two years at the Forest School, and one year of *stage*, or practical training, under some experienced officer in the forests themselves, where administration and the hundred-and-one other details of a forester's duty are learned, but by the new arrangement it would appear from these letters that two years would have to be spent in studying purely agricultural subjects, after which two more years would be passed in the *Ecole d'application des forêts*, or, as it seems to us, a sort of agronomic forester is to be turned out, pretty much such a one as would be produced after a period of study at Cirencester with lectures on forestry. Whether this surmise is correct or not, it seems at any rate to be clear that the forester of the future will spend a large portion of his time in studying a number of unnecessary subjects when he might be learning his real duties much more thoroughly. M. B. de la Grye, the author of the second letter, appears to admit that the freshly turned out officers might be the better for a little more practical training,

and certainly the course at the Nancy School itself can do nothing to teach a man those administrative duties which take up so much of an officer's time. To improve this, a second year of *stage* might perhaps with advantage be added, by which the French training would more closely resemble the German method, but to put two years of agriculture against the period of *stage* does not look like a change for the better.

On the subject of expense, it is not so clear that there would not be gain, although we cannot think anything appreciable either way would result. As far as the State is concerned, Marcel Taillis considers the saving would be enormous, since the *immenses locaux* of the Nancy Forest School would (in his opinion) fetch a large sum, in addition to which the chairs of Agriculture and Natural Science (which no doubt are already in existence at the Agricultural Institute) could be dispensed with, while, lastly, our poor old friends, the *adjudants*, would not be required. But M. B. de la Grye well points out that the school buildings could only be considered as *matériaux de démolition*, by which we suppose he means that these buildings, constructed as they are for a special technical purpose, would not be of any use in any other capacity; while as to the two chairs and the *adjudants* he does not think any large sum would be realised by their suppression. Further, he considers that the necessary expenditure that would have to be incurred in providing additional lecture-rooms, and so forth, at the institute, would counterbalance the savings obtained by the sale of the Nancy School. And it certainly looks on the face of it, as we said before, that no very great gain or loss would come of these arrangements. Besides which, there is the fact that the Nancy School is already set up with all the necessary appliances, and has every requisite on the spot. Next the question of the expenses of the students is considered, and Marcel Taillis talks a great deal of what sounds very like foolishness (we wish "bosh" were admissible) about the great waste of money indulged in by the students at Nancy by reason of the high social position which they hold, and which position, Marcel Taillis says, would be much reduced at Paris. This last may be true enough, but we should consider it rather a subject for regret than otherwise. But as to the extravagance, old Nancy men will not be able to recall anything very huge in this direction, the only things we can at this moment remember are *les vastes punchs, les brilliantes gaietés*, the subscription to which, however, cannot have amounted to much among so many. M. B. de la Grye, on the other hand, quietly points out the very evident fact that it is easier to spend money in Paris than at Nancy. But one would have thought that the question of expenditure on such a comparatively small matter as a training school would not be worthy of consideration with a great nation, while the kind of officer turned out was not the best obtainable.

LIGHT GRAZING IN THE RESERVES.

As the injury done by grazing varies, to use a mathematical expression, from infinity to zero, it is evident that it can be light enough to be, practically, harmless. The precise point at which it ceases to be harmless and becomes injurious has not as yet been fixed; but it is probable that grazing heavy enough to keep down the long grass, would interfere with, and not facilitate, the reproduction of trees. For the injury done by the trampling and browsing of the cattle varies directly with and counterbalances the good done by the keeping down of the herbaceous growth.

But even if we admit that light grazing does no injury to forests of a certain age, and that long grass interferes with their reproduction, there is still much to be said against allowing cattle into the reserved forests.

1st.—Even if harmless grazing is unnecessary for cultural reasons.—Reproduction can be facilitated, where this is required, without injury to the forest, and much more expeditiously and certainly, by human labour than by the unconscious action of cattle.

2nd.—Grazing may become a permanent impediment to forest improvements.—However light the grazing allowed, it would be difficult, in India, to stop it for a time, if this became necessary for special reasons. Indian cattle owners keep as many cattle as can find a bare subsistence on the available grazing area. They do not regulate the number of their stock by the pasture they possess, but let the amount of pasture regulate the number of their stock. To close grazing land which had been open for a number of years would, in most cases, cause the death of the cattle which the extra grazing had called into existence; and experience teaches us that the Forest Department is not always strong enough to resist the opposition that the closing would give rise to on the part of the cattle owners and the District officers. Grazing would thus prevent the artificial improvement of the forests in which it was allowed.

3rd.—There would be no saving in expenditure on fire protection by allowing the forests to be grazed.—The grazing itself would require expensive control to prevent its being increased to an injurious pitch. It would also be necessary to watch the grazed areas more closely than would be the case on closed areas, in order to prevent the cattle owners from injuring the trees and from setting fire to the forest, either through carelessness or deliberately, in order to obtain an early crop of grass, as was always done in

former years. Grazed forests are inflammable, and in the hills, the coniferous forests are equally inflammable, grazed or not.

4th.—Opening the reserves to grazing would injure and not benefit the surrounding population.—The cattle owners breed as many cattle as can subsist in ordinary years on the land they possess ; consequently a large portion of these cattle die off in years and seasons of abnormal scarcity. In the neighbourhood of closed and protected areas, from which grass and fodder can be obtained in all years, this can be prevented. The utility of these closed areas is not yet generally felt, because their area, in most parts of India, is insufficient to have any marked effect on the preservation of the cattle.

W. E. D'A.

OBITUARY.

We regret much to have to record the death of Mr. Edward H. Boileau, Deputy Conservator of Forests in Madras. Mr. Boileau was the son of a well-known Madras officer, General Boileau, and entered the Department in 1872. His chief service was in the forests of the Kurnool, Godavari and Kistna Districts, in all of which hard work in unhealthy places had acted to undermine an originally strong constitution. In 1880 he was deputed to select reserved forests in the feverish jungles of the taluk of Bhadrachálam on the Godavari, and his selections have formed the basis on which later and larger selections have been proposed. His organization of the revenue work in those forests is still in force. In 1883 he was transferred to the Kistna District, where he completed the selection of reserved forests under the new Act, and reorganized the work of the old jungle conservancy department. He was unsparing in his endeavours to do justice to his charge, and neglect of his own comfort in the interests of his work brought on the periodical attacks of fever and dysentery to which he eventually succumbed. He was taken ill at Guntur in October, and died at Masulipatam on November 3rd.

Mr. Boileau was a favorite in his station, liked both by his superior officers and his subordinates, while his interest in and kindness to the people, and his charity to the poor, was attested by the number of poor natives who crowded to his funeral.

CUSCUTA REFLEXA.

The Government of Mauritius has addressed the Government of India in order to ascertain from the Indian Forest Depart-

ment what information is available regarding injuries to trees in India by the *Cuscuta reflexa*, or by other species of *Cuscuta* growing parasitically, and we hope that the question may be dealt with by some of our readers, and that we may have some valuable notes to communicate on the subject.

Our own experience only points to injuries to orchard and roadside trees, as the *cuscutas* do not generally attack trees growing in masses, except perhaps in the case of scrub *zyzyphus* jungle, but we shall be much obliged for any information gathered from the personal observation of any of our readers.

CHLOROPHYLL.*—Mr. Gilbert showed in some experiments that pure nitrogen manures produced more chlorophyll than nitrogen and ash manures mixed, but that under the latter far more *carbon* was assimilated than under the former treatment. Potash is as essential for the assimilating power of chlorophyll as iron is for its formation.

A COMPANY has been formed in Bombay, under the name of the Siam Forest Company, to work a large concession of forest rights which have been granted to it by the King of Siam. The forests conceded to the Company are situated in the valley of the Moung Guan, about 30 miles east of the town of Laikon, and they cover an area of over 2,000 square miles. Much teak is said to be contained in them, and that of unusually large dimensions. The country is intersected by rivers, including the Menam, on the banks of which stands Bangkok, which will supply every outlet for trade. A manager with a staff to work the timber is now on his way to this land of promise, and operations will be commenced immediately.—*Pioneer*.

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* "Nature," Vol. 33, November 26th, 1885, page 92.

III. Notes, Queries and Extracts.

Arboriculture, Queensland.—Cultural operations have been restricted to experimental works on Fraser Island, of which about three-eighths, or 107,000 acres, are reserved. It is a large island separated from the main land by a strait varying in width from two to seven miles; the whole area is more or less wooded, in some parts covered with a dense tropical growth constantly moist; in others nearer the sea, with undergrowth of bracken fern and grass-tree. This reserve has been well-selected for experimental work, being conveniently close to Maryborough, a very rising and important place, and being on a thinly-populated island, there is less danger to be anticipated from bush-fire or general clearing. The species represented in the thin scrub are chiefly worthless honeysuckles and gums, with a young growth of cypress pine, which, under protection, appears to shoot up thickly and well.

On the banks of the creeks and rising to even the summits of the low ridges on the less exposed and moister slopes, we find myrtles, the Kauri pine, Queensland beech, palms, and even tree ferns; large specimens up to 30 feet in girth of "Syncarpia," which, along with the pines, reach a height of 150 to 200 feet.

In parts, the undergrowth is of almost pine myrtle, arranged in shrubs up to 20 feet high, but more generally the tall trees are surrounded by a forest growth of poles of very slender growth of the various species represented in the largest timber.

The soil is a decided sand, pure where the mangrove grows to the water's edge, and more or less loamy towards the moister forest: probably on this account the island has remained uncleared, and is only used for grazing stock along a small strip on the side towards the Pacific Ocean where horses are kept.

The timber, then, has only suffered at the hands of merchants who, since they commenced desultory working in 1864, have been contented to remove such specimens of Kauri pine and other species with a high commercial value as were conveniently shaped or situated for export.

In order, then, to secure the regeneration of the Kauri, which with Cedar and Bunya form the most valuable species in Queensland, a certain small sum has been yearly voted for expenditure on Fraser Island, and up to date the amount of £936 has been spent on the works in the following way—

In 1882 a strip of forest was cleared of all low undergrowth

to a width of one chain on either side of the road along one-quarter of a mile, Kauri pine seedlings being alone left standing, and young plants of the same species picked out where growing in bouquets and planted in line in the cleared land at distances of 4′ × 4′ and 5′ × 5′.

During the first year 28,000 young plants were so distributed, and they now average a foot and a-half in height, and have all the appearance of sturdy but slow-growing plants. The two seasons since their planting have been very dry and the growth in consequence abnormally slow: it remains to be seen what the present moist season will effect. The plants near the road are on the whole the most promising, and their new season's shoot is well started. Possibly these specimens are the better for the more air and light they enjoy along the road, and it may become necessary to let in more air and light to the rest of the plants by either killing out some of the shorter poles around the plants and thereby heightening the cover, or by removing or ring-barking the big trees where not required as seed bearers, the fresh growth being established. Some of the self-planted natural Kauri seedlings in these clear spots average 5 to 10 feet in height, and they do not present a stunted appearance; but it is not easy to discover what their real age is, for many conifers submit to remain suppressed for a long period without losing their vitality; so it is just possible these young looking kauries would be themselves the better for more light and air.

An experiment was also conducted in planting out transported seedlings in the open, with the result that the plants dried up. Under these circumstances care must be taken when letting light in on the plants that they are not too suddenly exposed to a hot sun, which on this sandy soil would have a very drying effect. The plants put in, and once fairly started, the soil should not be cleared of any re-growth of underwood, for it will be a useful adjunct to the pines when they are grown up.

Further on I visited the lines cleared in the undergrowth, and in which transplanted seedlings have been put out at a distance of 6 feet, the lines themselves being one chain apart: in this way 110 plants are distributed in each acre, and these with the naturally placed seedlings, which here occasionally reach 150 to the acre, are quite sufficient to ensure a complete regeneration if afforded protection and care.

The plants when put out in the cleared lines in 1883-84 had passed through nursery beds where they were watered during one dry season, thus giving them a start over the natural growth of forest plants.

The success of the transplants has been on the whole fair; in some portions very few have died, while in others the deaths have been more numerous, probably due to the weather being too dry when they were put out, or caused by damage to the

roots during the operation. It was not possible to judge of their growth as they are only now starting their season's shoot.

The nurseries themselves are cleared portions on gently sloping ground, in which the seedlings are put very closely in ridges about 6 inches apart, the distance between these ridges being annually increased by the removal of the first one, and then a second line of plants between two others. Shelter from the sun is afforded by a flat roof of brush 5 feet from the ground. At the present time there are new and old nurseries all stocked with plants, and I am of opinion that it would be well for the future to either put the young plants further apart in the lines originally, or to thin them out periodically, even if the seedlings removed in these thinnings are lost in the operation.

In protecting nurseries from too strong direct sunlight care should be taken to construct brushwood roofs as high from the plants as possible, to prevent the drip in rainy weather from rotting the plants. No precaution that I can suggest will stop the damage caused by the disease, which attacks the leading shoot of cultivated as well as natural plants of the Kauri.

This disease is worthy of continuous study in tracing its cause, progress, and effect. From what I was able to discover it appears to stop the upward growth of the plant until it forms a new leader below the diseased part, probably during the following growing season. It would be worth while to cultivate and identify the insect which causes this blighting effect, and this could be done without difficulty if, as I imagine, the dead leaves contain the larvæ of the insect itself.

In the operations up to date, during three seasons 59,000 plants have been put out in about 312 acres, at a cost of £936 to close of December 1884. This includes the cost of preparing the nurseries, containing now 58,000 plants ready to put out, and the clearing of lines in 136 acres, in which some 15,000 of the plants are now to be put.

The forest between the lines is in parts well stocked with bouquets of natural seedlings, and these have been counted and registered, and very many of them cleared of other growth interfering with their early development. Judging of the operation as a whole, it can not be said to have been expensive, or the money otherwise than well invested. It is too soon to judge of what the result will be, but I have no hesitation in saying that as an experiment it is of the utmost utility in throwing light on the natural history of the pine in question, and the knowledge now to be gained by a careful periodical registration of the progress in growth of the plants, as well as the patient study of the phenomena attending this growth, will be invaluable when the time comes, as it must, for Queensland to take steps to recover in some measure the grand timber forests of this and other light-wooded species which are now being sacrificed for no public end. So far from declaring the futility

of the experiments such as are now being carried on in Fraser Island, I would suggest the institution of similar experiments in other selected portions of the great littoral forest belt of the Colony, in order to study closely the habit and growth of all the different pines, cedars, and even gums, if the Colonial Government is in a position to avail itself of anyone who is able to devote time, knowledge, and perseverance to the work. The commencement of "Extended Forest Conservancy" in Queensland is only a matter of time, for as soon as public opinion recognises that the forests are a public trust, for which the Colony is responsible, and that no generation has more than a right to use without abusing this public property, then it will be a matter of absolute necessity to take stringent measures towards conservation, which will call for all the more self-sacrifice the longer the day for their institution is put off.

SYDNEY, N. S. W., *29th January, 1885.* E. D. M. HOOPER.

EVAPORATION IN TANKS.—A few weeks back Mr. Bruce, the Chief Inspector of Stock, had a conversation with Dr. Lendenfeld upon devising some plan by which the rapid evaporation of water from the Government tanks could be prevented. The latter gentleman has since then given the matter close attention, and has forwarded the following reports to the Minister of Mines, who has kindly placed it at our disposal :—

The causes of evaporation are the following :—1, Dryness of the air ; 2, High temperature ; 3, Wind.

I shall deal with each of these points separately. The dryness of the air is a certain factor with which we must reckon, as it does not lie within our present means to alter it. The only way to prevent the dryness having the effect of causing evaporation is to cover the surface of the water and shut it off from the air. The smaller the open surface the less evaporation there will be. By making the things deeper and narrower, or by covering the surface of the water with boards, this might be achieved. Both these methods are expensive, and would prove very inefficient. The method I could recommend, would be to plant certain water-plants in the tanks, *Nymphæa* for instance, which spread their broad and flat leaves on the surface of the water in such a manner that the lower surface is immersed, whilst the upper surface is exposed to the air and dry. The high temperature is perhaps the most important factor as regards evaporation. The higher the temperature the quicker the water evaporates as far as the temperature of the water is concerned. The temperature of the air has an effect only in so far as the higher the temperature the greater the capacity in the air for aqueous vapour the dryer the air will be. We cannot lessen the heat of the air,

but we can decrease that of the water by shading it from the sun. Shade might be obtained by planting trees around the margins of the tanks and on little islands made in the inner part for the purpose. Shade could be obtained by covering the tanks in with artificial roofs. The former would be very inefficient and the latter very expensive. I would recommend procuring shade by planting the water plants mentioned above, the broad leaves of which would effectually shade the water as they always cover the whole of the available surface with their leaves when growing well. The winds, particularly the notorious hot winds, cause an immense evaporation in various ways. Firstly, they ripple the surface of the water, which when roughened, must greatly increase the evaporation, inasmuch as the surface of water exposed to the air becomes twice or even more as great as when the water is tranquil. Secondly, the wind moves the air rapidly along the surface, and so the air, which has already taken up moisture, is rapidly replaced by air still dry which again takes up moisture from the tank. The wind might be kept off by constructing a corrugated iron wall on the western side of every tank. This, however, would be a very inefficient method. The formation of small waves could easily be stopped by beams anchored to the bottom and floating on the surface. But also here, it is apparent that the leaves of the water lily preserve the water very much better than any other means. The aquatic plants with wide spreading leaves on the surface are numerous. In Europe there are three species which might be utilised for the preservation of our water. Of these *Nymphæa alba* has the largest leaves, and could therefore be highly recommended. In Brazil a plant grows with leaves floating on the surface of the water, which are so large that large birds can walk over them. This plant is the *Victoria regia*. It will, however, not be necessary for us to look so far for the desired plant, as there exist some Australian species admirably adapted for our purpose.

Nymphæa gigantea, (Hooker).—This plant has leaves measuring 18 inches across, and has been found in many lakes and marshes in tropical Australia in Wide Bay and Moreton Bay, in Queensland, and in the Clarence River, in New South Wales.

Nelumbium speciosum.—This species has leaves from 1 foot to 2 feet in diameter. It grows in swamps and rivers in Northern Australia, and has been obtained in the Mackenzie River, in Queensland. Should these species not thrive in the tanks of the interior, experiments might be made with the European species, *Nymphæa alba*, *Nuphar luteum*, &c. On the ground of these statements, I beg to propose to the Minister of Mines to carry on a few experiments with all species, Australian and foreign, available, to ascertain which would be best adapted for the purpose, and at the same time I would propose to carry on experiments in the Botanic Garden, in Sydney, where some *Nym-*

phæa grow, to ascertain by direct observation the difference in evaporation between a tank in which such plants grow and one which does not contain any. The whole investigation would not involve either much time or much expense. The water lilies have a very beneficial effect on the water, and keep it clean and pure. In the Botany Reservoir, 15 years ago, there was a luxuriant growth of such aquatic plants, and I have been informed that the water in that reservoir was much better at that time than since the plants have been cleared out. In the springs which feed the water supply to Vienna, notoriously the best city water in the world, an abundance of plants are allowed to grow.

The large surface of the plants affords a resting place for dirt and bacteria, which when once in contact with the plants, will be attached to them very firmly, and finally oxydised and rendered harmless by the abundant oxygen continually produced by the plants.

To prove these statements, it would be advisable to procure from two parts of a tank shut out from one another, on one of which the water lilies grow, and to analyse both when the improvement effected in the quality of the water by the aquatic plants can easily be demonstrated.

Mr. J. Duff, of the Forest Department, has appended the following memoranda to the above :—

The planting of water lilies would no doubt have the effect of preventing evaporation and purifying the water, and the following would be the most suitable species to plant, *viz.* :—

Nymphæa lutea, a North American species, is the quickest growing kind with which I am acquainted, and closely covers a large space of water with its leaves in a remarkably short period. *Nymphæa alba*, a British species, is also suitable for the purpose, and has much larger leaves than *N. lutea*, but it does not increase so readily, or cover so much space. *Nuphar lutea*, also a British species, suitable for planting in any part of the colony, and the three species named, are all I would recommend to plant, and seeds and plants of each could be obtained from the Sydney Botanic Gardens.

The plants should be in boxes containing at least a square yard of soil intermixed with well decomposed cow manure, and if the boxes are placed at a depth of not more than one foot under the surface of the water, the lilies will thrive better than if deeper immersed.

The Royal Water lily (*Victoria regia*) and the Queensland *Nelumbium speciosum* will not grow in the open air in this colony, as the water in which they grow requires to be kept at an even temperature of 90° to 95°. *Nymphæa gigantea*, the Queensland Water lily, will grow moderately well in the neighbourhood of Sydney, but it would not thrive in districts subject to severe frosts.—*Sydney Mail.*

THE DESTRUCTION OF BIRDS OF BEAUTIFUL PLUMAGE.—A few months ago you kindly gave me the opportunity of saying something about the ruthless destruction of birds in New Guinea and the neighbouring islands. Owing to the partial annexation of New Guinea and the assurances I received that the trade in the plumage of beautiful birds was diminishing I let the subject drop for a while. In April, however, I went to an auction room, and, after looking at the bodies of hundreds of birds, ascertained that between December 1884, and April 1885, there had been sold 6,828 birds of paradise, 4,974 Impeyan pheasants, 770 so-called Argus, 404,464 West Indian and Brazilian birds, and 356,389 East Indian birds of various kinds. Leaving the City, I went to another district, and there saw the birds being mounted for the milliners, upholsterers, and dealers in fancy articles. Pursuing the birds still further, I traced the breast of a Lophophorus Impeyanus to a general servant's Sunday hat, and some humming birds and a kingfisher to a shop in a popular watering-place, where cabinet photograph frames were adorned with three birds and a dead kitten. I was inclined to believe that, in spite of the numbers of birds sold, the demand for them was confined to people whose taste was gratified by a vulgar display of what had the appearance of costliness. Last week, however, I heard of an order being given by a young English lady for a dress to be trimmed with canaries. Fortunately, before the order was carried out, she, being capricious, changed her mind, so only eight little birds were sacrificed to the prevailing craze for yellow.

My object in bringing the slaughter of birds to your notice is not to endeavour to excite a feeling of pity for them from a zoophilic point of view, for one of our leading ornithologists tells me that the hearts of the ladies who listen to his pathetic appeals are quite hardened on such a point, but to endeavour to check the career of the money-grubbing wretch who, by means of his shooting scouts, lays bare the tropical forests of their chiefest beauties, and who is akin to the miserable destroyer of plants, the mischievous name-cutting globe trotter, and the sordid speculator who would willingly chop up the garden of Eden into building lots and dispose of frontages to the Brook Pison. Is there no society willing to care for the beauty of the world? If ancient monuments can be, thanks to the energetic Sir John Lubbock, protected from Stonehenge to Nikko, surely some plan can be devised for making a general work of destruction at least unfashionable.

In these serious times, it may seem a piece of paltry sentimentality to ask the public to spare a bird, a flower, or even a lovely nook or corner of the world from destruction, but, in reality, it is to raise the tone of their minds by fostering a care and regard for what is beautiful and elevating.—GEORGE A. MUSGRAVE.—*The Times.*

A FORTNIGHT ago (May 23rd, p. 362) we called on Mr. Inspector Palmer to explain why he preferred good hardwood to stone or iron as an impediment to fire in a burning house. His *ipse dixit* goes for much, but his reasons would be still more convincing if they were shown to be well-founded. The question was worth raising, in order that the subject might be more fully investigated, and the preference for hardwood established in public opinion if justly entitled to it.

Now, instead of Mr. Inspector Palmer, Mr. G. T. B. Cobbett takes up his parable, and stands forward (p. 385, last week) to justify the Inspector's opinion, and he certainly makes out a strong case on behalf of good hardwood, by referring to instances of its saving value that came within his own experience and notification. Another correspondent ("S. T.") asserts that iron rafters and girders, which are coming more and more into use for public buildings, by their expansion at a high rate of temperature, "may positively force out and throw down the walls."

It has been estimated that taking the average temperature between winter and summer (that is between ice and hot sunshine) at 70 degrees, and the distance between London and Edinburgh at 400 miles, the metals of the railroad will be 338 yards longer in summer than in winter. Also it is found that iron expands lineally about $\frac{1}{14677}$th for every additional degree of heat by Fahrenheit's scale; and when we consider the intolerable temperature to which the iron pillars and girders of a burning house may be raised, without even being red hot, it will at once be understood that no fireman ought to venture within its walls when the flames had once got a firm hold of it, nor till long after it has had time to cool down.—*Timber Trades Journal.*

SICILY.—Let us look at Sicily, once the great grain reservoir for Rome. Since the island of plenty was despoiled of its forests, it gradually lost its fertility and the mildness of its climate. The ruins of proud and opulent Syracuse lay in a desert, covered by sand, which the hot sirocco carried over the Mediterranean Sea from Africa. A few isolated, well-watered, and carefully cultivated districts of very limited extension, is all that is left to remind the tourist of the by-gone glory of Sicily.—ROTHE.

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FOREST ORGANIZATION FOR BEGINNERS.

(*Continued from page 14*).

SECTION III—ASSESSMENT—(*continued*).

DETERMINATION OF THE CONTENTS OF GROUPS.—(*continued*).

II.—BY MEANS OF SIZE-CLASSES AND HEIGHT-CLASSES.

ALTHOUGH the accurate determination of heights is not nearly as important as accuracy in the measurement of diameters, still, it may occur in seedling-forests that groups are so irregular that one height-class will not suffice. Hence the necessity of sometimes having more than one.

The method, just described, in which test-trees are cut for each major-class, certainly does tacitly assume that separate heights are required for each major-class, but it also takes for granted that the heights of trees in each class are proportionate to their diameters, and that the form-coëfficients of all trees of the same diameter are practically the same. But in very irregular forests, such as stored coppice or 'primitive' forests, and also in those in which the station is very variable, such as may be the case when a group is partly situated in a sheltered and rich basin, and partly on an exposed hill-slope—in such instances, the heights and form-coëfficients of trees of the same diameter may vary very considerably, so much so indeed that it may be expedient to adopt the following method in which each tree is put into a certain height-class when its diameter is measured. For this purpose, the assessor, when the diameter of a tree is called out, takes a rapid glance at it, estimates its height-class by eye, and enters it accordingly in the field-book. Before commencing, he will have to decide how many height-classes are desirable. This will depend on the degree of accuracy required, and of the irregularity of the group; but the work of

estimating heights rapidly is fatiguing and confusing, and three, or at most four, classes are as many as can be managed. Any how it will generally suffice if the classes proceed by differences of 10, or even 15, feet: for example, all trees 75—85 feet (average 80) might be classed together, and, again, all those 85—95 (average 90 feet), and so on. The assessor should practise judging the heights of trees of different classes, and not commence work until he finds he can tell the class of any tree pretty accurately.

The form of field-book given at p. 7, would have to be altered to the following, supposing there were two height-classes, and two species :—

Diameter-class.	Teak.				Xylia.			
	1st height-class, 35—45 feet and under.	Total.	2nd height-class, 45—55 feet and over.	Total.	1st height-class, 35—45 feet and under.	Total.	2nd height-class, 45—55 feet and over.	Total.
6		23		12		52		25
$6\frac{1}{4}$		30		16		20		20
$6\frac{1}{2}$		21		12		45		15
		&c.		&c.				

In this example, 23 teak trees would have, for the purpose of calculating the contents of the group, a height of 35—45 feet (average 40) for the diameter-class 6 inches, and 12 would have a height of 45—55 feet (average 50).

The contents for each class would then be calculated by one of the methods described at p. 8, *et seq.*

When the irregularity of a group is owing to differences of station, it will generally be found that a stretch of tolerably uniform forest succeeds another also tolerably uniform after its manner, or the one is merged imperceptibly in the other, as may be the case on hill-slopes when groups often fall off pretty uniformly without any sharp lines of demarcation. In such cases it will generally suffice to divide a group by imaginary lines separating approximately the different classes of forest, and to calculate the contents of each one, as if it were a group apart, without height-classes, by means of one or other of the

methods already described. For instance, on a slope, where it is decided to have two sub-groups in a group gradually falling off from the higher-lying to the lower-lying ground, it might be divided by a horizontal line into two strips, each representing a sub-group: the test-trees should then be taken from a spot near the centre-line of each strip, so as to obtain trees of average form. The contents of the group would of course consist of the sum of the contents of each sub-group.

III.—Determination of the Contents of Groups by means of Form-Coefficients, without Fellings.

At p. 8, the form-coëfficient of a tree was explained, and found to be represented by the fraction $\frac{c}{a \times h}$, in which c represents the cubic contents of the tree, a its basal area at $4\frac{1}{2}$ feet from the ground, and h its height. It is the fraction which, when multiplied by the basal area and height of a tree, gives its cubic contents. If, now, we know that a certain tree has the same form as one whose coëfficient we have already obtained by means of a felling, all that would be necessary, in order to find its cubic contents, would be to measure its height with a hypsometer, and its diameter at $4\frac{1}{2}$ feet from the ground. If, for example, the coëfficient of a tree is known to be ·50; its diameter, at $4\frac{1}{2}$ feet, 2 feet; and its height is found by the hypsometer to be 40 feet; its cubic contents would be $\cdot 5 \times 40 \times 4 \times \cdot 7854 = 61 \cdot 8$ cubic feet, the basal area of a tree being equal to the square of the diameter multiplied by ·7854.

The object, however, which is to be sought in the present case is not the coëfficient of each single tree, but the average coëfficient of a number of trees of about the same form and height. And this is what is to be aimed at in the construction of tables, which should show the average coëfficients for groups of various heights growing under average conditions.

By employing coëfficients in this manner, all fellings are avoided, and, as it is frequently inconvenient to have to fell test-trees, it is a method often employed for fairly regular and fairly well-stocked groups. For many years past, experiments on a large scale have been systematically carried out under the auspices of the German Society for the advancement of forestry, with a view to the construction of tables showing the average coëfficients for groups of certain heights and average density, and the results obtained by means of those which have been already issued have been shown to be as satisfactory, when used under the conditions assumed, as perhaps any other method for determining the contents of groups. The heights of groups are taken, instead of their ages, as a standard of comparison, because it has been found that the form depends much more on height than on age; and well-stocked groups of average density

are chosen because, of course, such groups under the conditions assumed are most numerous. Tables of this kind would not, therefore, answer in the case of very dense groups, and still less for very open groups. For this reason, tables are sometimes constructed which give the coëfficients for groups of various densities and quality. König, for instance, gives the following table for Scots' pine. He gives five classes—(1), For sickly trees growing up crowdedly in poor stations ; (2), For tolerably dense groups in good condition ; (3), For more open groups of trees with good crowns, and long full boles ; (4), For open groups ; trees with fuller crowns, more spreading, and more thickly branched. The heights are given in Prussian feet, which are smaller than English feet, but, as the table is merely given by way of illustration, and as it is of no value for Indian Foresters, even supposing it to be a reliable one, which is probably not the case, it does not seem necessary to reduce the figures to English measure.

Table of Coefficients of Form for Scots' Pine and Larch, exclusive of branches (König).

Height of Tree.	I.	II.	III.	IV.
10	0·491	0·531	0·590	0·666
20	0·486	0·526	0·584	0·660
30	0·481	0·521	0·579	0·653
40	0·476	0·516	0·573	0·646
50	0·471	0·511	0·567	0·640
60	0·467	0·507	0·562	0·633
70	0·463	0·503	0·557	0·627
80	0·458	0·498	0·552	0·620
90	0·453	0·493	0·546	0·613
100	0·449	0·489	0·541	0·607
110	0·445	0·485	0·536	0·600
120	0·440	0·480	0·530	0·594
130	0·435	0·475	0·525	0·587
140	0·430	0·470	0·520	0·580

It is scarcely necessary to observe that tables of coëfficients, which represent the averages of a large number of trees, cannot be employed with advantage for estimating the cubic contents of one or two trees only. To get good results, it is necessary that the investigation should be extended to a considerable number, say not less than a hundred.

The construction of tables on this principle is simple enough. Fairly well stocked groups of various heights and medium quality are selected, and the basal areas at $4\frac{1}{2}$ feet from the ground of each one determined. Each group is then felled :

the lengths of all trees comprised in it are measured to the outtermost branches, and added up: and their cubic contents are calculated, and added up. The average coëfficient (f) will then be represented by a fraction which has for its numerator the contents of the group (c), and for its denominator, the sum of the heights of all trees (L) multiplied by the sum of their basal areas at $4\frac{1}{2}$ feet from the ground (A). The formula for this operation would, therefore, be

$$f = \frac{c}{A \times L}.$$

It is usual to calculate two coëfficients, one for the whole tree, including branches (tree-coëfficient), and one for the timber only (timber-coëfficient), which should generally include all wood useful for anything except firewood, or all wood up to a certain diameter. In this way, Kunze determined the timber- and tree-coëfficients of 4,638 Scots' Pines of various ages and medium quality, growing under average conditions, and the results of his investigations are given below for the sake of illustration.

Height of tree, meters.	Timber-coëfficient.	Tree-coëfficient.	Height of tree, meters.	Timber-coëfficient.	Tree-coëfficient.
5	·07	·94	16	·48	·56
6	·13	·85	17	·47	·54
7	·19	·79	18	·47	·53
8	·25	·74	19	·47	·53
9	·31	·69	20	·46	·52
10	·37	·66	21	·46	·51
11	·41	·64	22	·46	·51
12	·45	·62	23	·46	·51
13	·47	·60	24	·46	·50
14	·48	·58	25	·45	·50
15	·48	·57	26	·45	·50
			27	·45	·50
			28	·45	·49
			29	·45	·49
			30	·44	·49

To use tables of this kind for calculating the contents of a group, it is necessary to determine—(1), the basal areas of all the trees of the group, and (2), its average height.

The sum of basal areas, A, will then be equal to

$$n_1 a_1 + n_2 a_2 + \text{\&c. (see p. 8)},$$

when n_1, n_2, &c., represent the number of stems of diameter-classes d_1 d_2, &c.; and a_1, a_2, &c., the corresponding average basal areas.

If the group is a mixed one, separate estimates must naturally be made for each species.

The mean height may be determined either (*a*) for each major-class, or (*b*) one average is taken for the whole group. In either case, the average diameter of a tree of any class at $4\frac{1}{2}$ feet from the ground is calculated from the sum of basal areas by the method explained at page 8, and the heights of a few trees of the average diameter thus obtained are measured for each major-class, if there is more than one class, by means of the hypsometer. The mean of these measurements for any major-class will of course give the average height of such class.

Sometimes, the mean height is determined by simply measuring a few trees of apparently average height without reference to the average basal area of one tree, but as the basal areas of all trees must in any case be worked out, the time saved is not likely to make up for the loss of accuracy.

Several methods for determining average heights far more elaborate than the above are frequently recommended, but none appear to be as accurate nor as practical as the one here recommended.

The cubic contents of a group comprising trees of the dimensions shown below, would be found in the following manner :—

Taking, first, one height-class for the whole group, consisting of—

100 trees of	10	inches diameter;	with, therefore,	basal area each of	·545	sq. ft.
200 „	$10\frac{1}{2}$	„	„	„	·601	„
250 „	11	„	„	„	·660	„
180 „	$11\frac{1}{2}$	„	„	„	·721	„
200 „	12	„	„	„	·785	„
140 „	$12\frac{1}{2}$	„	„	„	·852	„
130 „	13	„	„	„	·922	„

The diameter-classes, it will be seen, proceed by differences of half an inch.

The sum of basal areas will be

$$100 \times \cdot545 + 200 \times \cdot601 + 250 \times \cdot660 + 180 \times \cdot721 + 200 \times \cdot785 + 140 \times \cdot852 + 130 \times \cdot922 = 865\cdot62 \text{ square feet.}$$

The number of trees is 1200. Therefore, the average basal area of a tree is $865\cdot62 \div 1200 = \cdot721$ square feet, which corresponds to a diameter of 11·5 inches.

Let us now suppose that 20 trees of 11·5 inches' diameter are measured and found to have an average height of 50 feet, and that the table gives the tree-coëfficient for this height as ·60. The cubic contents would then be

$$865\cdot62 \times 50 \times \cdot60 = 25{,}969 \text{ cubic feet.}$$

Taking, now, two height-classes, the one comprising all trees of 10 to $11\frac{1}{2}$ inches in diameter, the other of all those which are 12 to 13 inches in diameter, there would be for the former a sum of basal areas

$$100 \times \cdot 545 + 200 \times \cdot 601 + 250 \times \cdot 660 + 180 \times \cdot 721 = 469\cdot 48 \text{ square feet.}$$

The number of trees is

$$100 + 200 + 250 + 180 = 730.$$

Therefore, the average basal area of a tree of this class is $469\cdot 48 \div 730 = \cdot 643$ square feet, which corresponds to a diameter of 11 inches.

Supposing that fifteen trees of 11 inches diameter are found to give an average height of 45 feet, and that the tables show for this height a tree-coefficient ·62, the cubic contents of the whole class would be

$$469\cdot 48 \times 45 \times \cdot 62 = 13{,}099 \text{ cubic feet.}$$

The contents of the second height-class would be calculated in the same manner, as follows :—

$$A = 200 \times \cdot 785 + 140 \times \cdot 852 + 130 \times \cdot 922 = 396\cdot 14 \text{ square feet.}$$

The number of trees is

$$200 + 140 + 130 = 470.$$

Therefore, the basal area of one tree averages $396\cdot 14 \div 470 = \cdot 843$ square feet, which corresponds to a diameter of 12·5 inches. Supposing that ten trees of this diameter are selected and found to have an average height of 55 feet, and that the tables give a tree-coëfficient ·58 for this height, the cubic contents of the class would be

$$396\cdot 14 \times 55 \times \cdot 58 = 12{,}637 \text{ cubic feet.}$$

Consequently, the contents of the whole group would be $13{,}099 + 12{,}637 = 25{,}736$ cubic feet.

B.—Methods of estimating the contents of groups involving the diameter-measurements of only a portion of the trees.

IV.—By means of Test-Plots.

By this method, only a portion of the trees in a group are measured, the contents of the remainder being deduced from the result. Any method employed in estimating the contents of whole groups may naturally be employed in calculating the contents of test-plots.

The object of employing test-plots only, is of course to save time and expense. It is a method which is very often employed in this country, even for very irregular exploitable groups, because Indian forests are generally very extensive and of small value when compared with the area they take up : the staff of officers is also generally too small to employ more exact methods.

In choosing a test-plot, care must be taken to select a piece of forest which is representative of the whole group. On hill-sides, for instance, it would generally not do to take the lowest-lying portion, nor the highest ; the estimate would probably be too high in one case, and too low in the other : the test-area should

be taken somewhere between the two extremes. A good plan, especially for large groups of irregular forest, in which average portions are very difficult to select, is to divide the whole into sub-groups in the manner described in the last sub-section, treating them separately, and having a test-plot for each one.

An elongated rectangular strip is the best shape for a plot, as that form is generally most likely to enclose an average section of forest, if the latter is at all irregular.

As a rule, not less than three-quarters of an acre should be taken as a test-plot. The rectangles can be quickly set off by means of a cross-staff, but the marking-off of plots is a slower process, owing to obstruction by trees, than might be supposed, and it will often be possible to estimate a whole group of known area as quickly as a plot of half its size, which has to be marked out. As regards the maximum limit of size, that cannot be fixed before hand; it must depend on the degree of irregularity and the size of the group, but probably, it will seldom be found necessary to exceed four or five acres.

There are two ways of estimating the contents of groups by means of test-plots. By the one, the area of the group and the test-plot must be known; by the other, these data are not required.

By the former, the cubic contents of the test-plot and its area being known, the cubic contents of the whole group will be found by the proportion $c' : c :: a' : a$.

When c' = contents of the whole group.
c = that of the plot.
a' = area of the whole group.
a = area of the plot.

Consequently

$$c' = \frac{a' \times c}{a}.$$

By the other method, all trees in the group are counted; a test-plot is then selected in a suitable part of the group, and the trees on it are measured as well as counted. Then, if

n = number of trees on the test-plot,
n' = number of trees in the group,
c = the cubic contents of the trees on the test-plot,
c' = the cubic contents of the whole group,

the contents of the whole group would be found by the proportion $c' : c :: n' : n$.

From which we get

$$c' = \frac{c \times n'}{n}.$$

No doubt this method is more likely to give accurate results than the former; unfortunately it is also much more troublesome to carry out, as all trees in the group have to be counted. But if all trees are to be counted, it would not take very much longer time to measure them as well, whereby still better results might be expected.

(*To be continued*).

CONTINUED GROWTH OF PINE LEAVES.

IN 1877 Messrs. Fliche and Grandeau, Professors at the Nancy Forest School, published in the 11th Volume of the "Annales de Chimie et Physique," (5th series,) an important paper on the changes which take place in the leaves of the Austrian Pine, *Pinus Laricio var. austriaca.* Their experiments were made in 1875, and in May, when the leaf buds of that year were not yet developed, the leaves of the preceding years measured as follows :—

Leaves of	1874,	length	70 m. m.
"	1873,	"	85 "
"	1872,	"	90 "

thus showing a successive increase in length. This, it is true, might have been apparent and might have been caused by an exceptionally favorable season in 1872, a less favorable season in 1873, and a still less favorable one in 1874. As a matter of fact 1875 must have been more favorable than 1874, for the leaves of that year (1875), which in June had attained 38—53 m. m., were in September 74—78 m. m. long. They were taken from the same tree. More detailed observation published lately by Gregor Kraus, a German Botanist, which will be noted further on, shows conclusively that the leaves of pines continue to grow after the close of the first year, and do not attain their full size until the second, and in some cases until the third year.

The great value of the experiments made by the two Professors of the Nancy Forest School, *consists in this, that they show* the successive changes which take place in the chemical constitution of the leaves of this pine from their first development to the end of their life. It is not possible in this place to do more, than to advert to the main features of the results established by these researches, which may briefly be summed up as follows :—

First.—*Older leaves are richer in solid matter.* The percentages in weight of water, and other volatile substances in the leaves of different ages examined in 1875 were as follows :—

Leaves formed in—

1875	contained in June 1875	70·6,	in October	57·6	per cent.
1874	"	58	"	59	"
1873	"	55	"	58	"
1872	"	51	"	44	"

The four year old leaves of 1871 in May contained 40 per cent. of water and other volatile substances before they dropped.

Second.—Older leaves are poorer in nitrogenous substances.

Third.—Older leaves contain a larger proportion of ash, as may be seen from the following figures :—

Leaves formed in—

1875 contained in June 1875	1·6,	in October	1·9	per cent.	of ash.
1874 „ „	1·8	„	2·3	„	„
1873 „ „	3	„	3·3	„	„
1872 „ „	3·2	„	4·7	„	„

The four year old leaves of 1871, examined in May 1875, before they dropped, contained 4·6 per cent. of ash.

Fourth.—Those constituents of the ash which are the companions of nitrogenous substances in plants, *viz.*, phosphoric acid, sulphuric acid and potash, form a smaller proportion of the ash in old leaves. Thus the ash of the leaves examined gave the following percentage of phosphoric acid :—

The ash of leaves formed in—

1875 contained in June 1875	28,	in October	14	per cent.
1874 „ „ „	11,	„	13	„
1873 „ „ „	9,	„	10	„
1872 „ „ „	9,	„	10	„

The ashes of four year old leaves of 1871, examined in May 1875, before they fell, contained 6 per cent. of phosphoric acid.

Fifth.—Lime is the chief of the constituents of the ash, which shows an increase in older leaves, as may be seen from the following figures :—

The ash of leaves formed in—

1875 contained in June 1875	15,	in October	45	per cent.	of lime.
1874 „ „ „	55,	„	57	„	„
1873 „ „ „	64,	„	62	„	„
1872 „ „ „	63,	„	70	„	„

and the ash of leaves four year old of 1871, examined in May 1875, before they dropped, contained 69 per cent. of lime.

Similar results have been obtained by Covenwinder with the leaves of *Prunus Laurocerasus*, the common evergreen Cherry Laurel. His experiments were reported to the "Académie des sciences" of Paris in February 1878, and an extract was inserted in the "Revue des eaux et Forêts" of 1878 (page 161). Young leaves were found to contain 32 per cent. of nitrogenous substances, while old leaves, probably more than a year old, contained only 11 per cent. And of the mineral substances phosphoric acid formed 1·7 per cent. in the new, and only 0·3 per cent. in the old leaves, while lime was more plentiful in the old than in the young leaves.

From these experiments and from others, which have given similar results, the conclusion may be drawn, that leaves of evergreen trees have different functions during different periods of their existence. Leaves just formed, of all trees, evergreen as well as deciduous, have their walled cells, which are full of nitrogenous substances, and they absorb oxygen and emit carbonic acid in the same manner as seeds during the process of germination.

Later on, during the remainder of the first and during subsequent years, their chief function is to carry on the process of assimilation, they absorb carbonic acid from the atmosphere and emit oxygen, until at last towards the end of their life, the process of assimilation seems to slacken, and they seem thus to some extent to serve as store houses for substances which are no longer needed in the living tree.

The researches lately published by Gregor Kraus* are limited to the continued growth in length of the leaves of evergreen trees. The result as stated by him is, that the leaves of evergreen Dicotyledoneous trees, such as *Quercus Ilex* and *Suber*, *Rosmarinus*, *Buxus*, *Myrtus*, *Ligustrum japonicum*, *Eucalyptus* and others, attain their full size during the first year of their existence, and that this is also the case with the species of *Cedrus*, *Abies*, *Tsuga*, *Picea* and other Conifers, save the Pines. Mathieu was aware of this, when writing his excellent "Flore Forestière." In the third edition of 1877, page 440, the subject is mentioned in the following words :—"Les feuilles des Conifères s'accroissent fréquemment pendant toute la durée de leur persistance, de sorte qu'elles sont d'autant plus longues, qu'elles sont plus agées." Gregor Kraus has now further established this remarkable fact by a series of accurate measurements for a number of species, of which the following may be quoted as instances :—

Section Pinaster (2 leaves in a sheath).

	Length in m.m. of leaves. 1 year old.	2 years old.	3 years old.
Pinus sylvestris, 15 years old, ...	45	49	52
„ 8 „ terminal shoot,	75	94	85
„ 8 „ side shoot,	70	81	81
Pinus Laricio, old tree, ...	135	160	...
„ young plant, ...	130	165	...
Pinus Pinaster, „ ...	60	88—90	120
Pinus Pinea, terminal shoot, ...	82	120—125	145
„ side branch, ...	85	120	130

Section Tæda (3 leaves in a sheath).

Pinus insignis, Dougl., ...	80—85	105—110	120
Pinus canariensis, ...	134	162	...

Section Cembra (5 leaves in a sheath).

Pinus Strobus, ...	70	85	...

Exceptions are, however, not wanting; thus when young weakly plants get stronger, the leaves of previous years are shorter than those formed after the plant had become more

* Botanische Mittheilungen von Gregor Kraus, Halle 1885.

vigorous. Again, leaves formed in exceptionally favorable seasons are longer than leaves formed in ordinary years.

Professor Kraus furnishes direct proof of the continued increase of leaves by a series of observations, which show the growth of leaves, one and two years old, during the season. Of this it will suffice to quote the following made in 1878 on a tree of *Pinus Pallasiana*, 15—20 years old.

Date of observation.	Leaves of the current year.	1 year old.	2 years old.
May 9th,	...	142·2	167·9
„ 28th,	11·5	143·3	168·7
June 18th,	87·0	143·4	169·3

Measurements of cells made by Professor Kraus in one and two year old leaves of *Pinus Laricio* and *Pinus uncinata*, show that the increase in length here described takes place chiefly in the basal part of the leaf, which is included in the sheath.

It would be a matter of considerable interest, to examine the Indian Pines and to ascertain, whether they show a continued growth, like the species here named, as well as to examine the changes which take place in the chemical constitution of their leaves during their existence. It would also be interesting, to ascertain whether no other evergreen trees in India show a continued growth of their leaves. The hope that some of my friends and former colleagues in India may find leisure and opportunities for making these researches, has induced me to bring forward the subject in the "Indian Forester."

BONN: *January, 1886.* D. BRANDIS.

LIGHT GRAZING IN RESERVES.

THE experiences of "A. J. C." as related at page 560 of the December Number of the "Forester" would appear to have been gathered in tropical forests, such as those in Assam or Oudh, had he seen as many of the plains forests of the Panjab he would not, I am sure, so readily give his opinion in favor of grazing, however "light" in the reserves. In tropical forests it may do little harm, nay even some good, but there can be no doubt that it is simply destructive in every way in such plains forests as the Rakhs of the Panjab, though perhaps he may say it is a misnomer to call them "forests" at all! This, however, does not effect the general question on which, I for one, have a strong opinion that, unless absolutely necessary for the wants of the villagers, no grazing of any kind should be allowed in reserves. There may be increased danger from fire by keeping out grazing rigidly, but in time as the trees grow up the grass will die down, under their shade, or be so small and thin that very little dam-

age can happen even should a fire consume it. So many dangers follow in the wake of grazing, that it is far better to keep it out altogether. As for what is termed "light grazing" I do not believe in it at all, because with the small establishment available, it must sooner or later become heavy to the last degree. I will now take the arguments of "A. J. C." in order, and say what my experience has taught me with reference to each of the points raised :—

(1). I cannot agree with this, I have seen the contrary in sál forests, and in the Panjab Rakhs it is most decidedly not the case ; there, the stricter the reservation the better the reproduction. In short I do not believe that anything absolutely prevents germination, though with long grass there may be less of it, still this is quite sufficient to re-stock a blank area, in time.

(2). Nor can I agree with this, my experience is that cows and bullocks make no distinction between a young seedling and a blade of grass. Of course if the grass is say 5 to 20 feet high there will be very little germination, but then cows and bullocks will hardly eat down grass of such dimensions.

(3). This is true no doubt, in such "open glades" there is very little natural reproduction, and these must be re-stocked artificially, but does "A. J. C." mean us to understand that natural reproduction in these places will as a matter of course follow light grazing ?

(4). We have no actual data to prove this, at present it is a mere statement that "one fire in a protected forest, causes more injury than a very long period of light grazing" ; for my part I would prefer to run the risk of fire than have grazing of any kind.

(5). How can it be said that "all this valuable grass is wasted and destroyed each year" if fires are kept out it is not destroyed, and if it simply dies down, it is not wasted as the soil is enriched by it. If it is of use to the villagers, then they might be allowed to cut and carry away as much as they want, as is done in hill forests.

(6). The revenue lost by prohibition of grazing is generally counterbalanced by the good accruing to the forest growth.

(7). If there is hardship inflicted on the neighbouring people by closing to grazing, then, either when the forest was reserved an insufficient area was set aside for them, or they have bred more cattle, and it has thus become insufficient ; the first can be remedied by us, and the second by the villagers themselves ; it must be borne in mind that the more grazing ground they can get the more cattle will they breed, and after a

few years of so-called light grazing, it will be found practically impossible to re-close the forest, for not only will the villagers claim a right to graze as before, but they will insist upon it to keep their cattle, now largely increased in numbers, from starvation. Petitions will go to Government, and the end of it will be that we shall have to give a right made possible by *our own folly*. It is of no use to say that they can be made fully to understand in the first instance that we are at liberty to turn them out whenever we like, they will fully agree to this at first, simply to be allowed to graze, but when the time comes, they will ask "where are we to go now." I have actually experienced this ; for only two years, I allowed grazing in a reserve, and as it was necessary to begin planting operations I gave the villagers notice to quit, explaining that when I gave them permission *it was only for a short time* as they knew. This they readily admit, but simply say "Yes, we know it was only till you required to plant, but we cannot live unless we are allowed to go on grazing," and so on, over and over again with "damnable iteration" till, I for one am fully determined never again to be led into such a position.

(8). I do not see that one pie of fire expenditure would be saved, what would be less expended on cutting lines, &c., would be compensated by the necessity for *increased vigilance on our part* both to prevent fire inside the reserve and to ensure that the "light grazing" did not become too heavy to be borne.

J. C. McD.

LIGHT GRAZING.

I WAS very glad to see in your last Number a letter on the interesting subject of "Light Grazing."

Your correspondent is an ardent advocate of it, and apparently wishes to introduce it in the forests under his charge in opposition to his Conservator's wishes, for surely nothing else could make him wish to have Conservators bound down on professional matters by a G. O. Each forest differs from its neighbour, and the question of how much grazing may be allowed must be settled in detail after we have gained the requisite knowledge by actual experiments carried out according to a definite plan, and the sooner these are set on foot the better. What is wanted is to fence off a series of 50-acre blocks *in the forest*, and put five cows in one, ten in another, fifteen in another, &c., &c., and carefully watch the result, and at the end

of 5—10 years we shall know what amount of grazing may be allowed in that particular class of forest. Of the eight arguments brought forward by "A. J. C." those which bear upon the point at issue have not yet been proved, and some of them I think are not capable of proof.

Nothing but heavy grazing keeps down the grass, and the effect of light grazing in every case that I have observed is to keep down the grass in certain parts while it grows just as tall as ever in other parts. The cattle have to be kept together to prevent their straying or their being carried off by tigers, and the net result of "light grazing" in the forests that I know is that one part is heavily grazed over and the rest left alone.

With regard to argument (3) it is well known that a considerable area of our forests was at no very remote period under permanent cultivation, and it is not probable that the former inhabitants when leaving those parts took the trouble to plant them up for the benefit of a future generation.

I have never yet seen a definition of "light grazing," and should be very glad to see one, by a competent authority, in your pages. We know that heavy grazing means admitting sufficient cattle to eat up the whole of the available grass, and that this generally results in the destruction of all seedlings that happen to be on the ground at that time. "A. J. C." seems to have jumped at the conclusion that with light grazing all the grass will be eaten and all the seedlings left. But judging from what we know the more probable result would be the removal of one-half of the grass and one-half of the seedlings, leaving sufficient grass to kill the remaining seedlings if it happens to catch fire.

"KONDA DORA."

NOTE ON CONES OF *PINUS LONGIFOLIA*, &c.

THERE is now no doubt that the seed of this species takes about two years to ripen. I say "about," as from the persistent nature of the cone which remains on the tree long after the seeds have fallen, it is difficult to say when they are ripe. The following facts I have established, *viz.*, that the cone first appears in February or March; that twelve months after it is still a small immature cone about one inch long; the ripe seed *falls* in July, but seed may be best obtained by picking the cones in February or March; the cones are persistent for a very long time, for I have seen them of four ages on one tree, first the infant cone, second a cone one year old, third a ripe cone, fourth an empty persistent old cone! The male flower appears I think about January, and the pollen falls in March. Unlike the deodar, male flowers and female cones are found on the same stem. I gather from my observations that deodar takes 14 months, kail 18

months, tos (*A. Smithiana*) 8 months, rai (*A. Webbiana*) 8 months, chil 24 to 27 months to ripen the seed, but should be glad if any of your readers can verify this from what they have observed.

J. C. McD.

12th January, 1886.

WOOD FOR DOG-CART SHAFTS.

Messrs. Dykes and Co., Coach builders, Calcutta, have applied to us for information as to any timber which could replace lancewood for dog-cart shafts.

They hold the opinion that *Sundri* (*Heritiera littoralis*) is the only Indian timber which approaches lancewood in its qualities.

It is possible that *Dhamin* (*Grewia vestita*) from Northern India, or *Bola* (*Morus lævigata*) a beautifully grained wood, almost exclusively used for paddles and oars in Assam, would serve the purpose, and if Messrs. Dykes and Co. could procure specimens of the latter from the Conservator of Forests, Assam, and would inform us of the results, it would be very useful.

Dhamin timber is well known, being used for kahars' carrying-poles as well as shafts, and we will supply Messrs. Dykes and Co. with some specimens. Male bamboos are also largely used as shafts in North-West India. We hope that some of our readers will give further information on this subject in our pages.

WOOD FOR CIGAR BOXES.

Mr. Sutherland, care of Messrs. Murray and Co., Meerut, has been enquiring for a good wood for cigar boxes resembling Spanish cedar, of which he says that a considerable quantity could be used in trade.

We can only suggest *Tún, Nim* or *Bokain* from Northern India, but as some wood from other provinces might be preferable, we hope that the matter will receive the attention of our readers.

IV. NOTES, QUERIES AND EXTRACTS.

ON THE INFLUENCE OF FORESTS UPON CLIMATE.—At the meeting of the Royal Meteorological Society, held on Wednesday, the 16th instant, a paper on the above subject, by Dr. A. Woeikof, was read, of which the following is an abstract:—The existence of an influence of forests upon climate has often been contested, and the question remained for a long time unsettled, because meteorologists were content with principles of too general a character. The first step towards a scientific investigation of the subject was taken by the establishment of the Bavarian Forest Meteorological Stations, the results of which have been published by Professor Ebermayer. The excellent example of Bavaria was soon followed by Germany, France, Switzerland, Italy, and other countries. As a general result it was found that during the warmer season (1) the air and earth temperatures were lower in the forest as compared with contiguous woodless places; (2) their variations were less; and (3) the relative humidity was greater.

The following details, referring to the amounts of evaporation from April to September, are quoted as being of special importance:—

	In the Open. Inches.	In the Forest. Inches.	Percentages.
Eastern France, ...	16·23	5·20	312
Alsatian Mountains, ...	13·19	6·26	211
Bavaria, ...	14·85	6·22	239
Brandenburg, ...	15·71	6·42	245
Eastern Prussia, ...	9·93	4·73	210
Silesian Mountains,...	10·52	4·17	250

It will be therefore seen that the evaporation from a free surface of water in the open was everywhere more than double, and even above three times that in the forest. In Bavaria, the evaporation from soil saturated with water was observed. This amounted in the same seven months to 16·07 inches in the open, 6·26 inches in the forest without dead leaves, and 2·44 inches in the forest with them. This experiment shows that the evaporation in the open is 6½ times as much as in the forest with the covering of dead leaves. The influence of the forest on the diminution of evaporation from water and ground is so great that it cannot be explained by the lower temperature of the warmer

months only by greater humidity, or even by the shade: one influence which has hitherto been too little regarded is especially important in effecting this result, *viz.*, protection from the wind by the trees standing closely together. This last cause is *probably more important in its effects than all the others put* together.

The diminution in wind force which is caused by the presence of trees is well known, although we have unfortunately no numerical data with reference to it: but it could easily be investigated by the erection of anemometers. It follows also, from the laws of Mechanics, that if this diminution of the wind by forests is especially evident in the lower strata of the air below the tops of the trees, it cannot cease above them, but owing to the so-called viscosity of the atmosphere must extend to a considerable height, so that the motion of the air is weakened up to five or even ten times the height of the trees. This indicates the extent of the favourable influence which forests must exert in *maintaining* the humidity existing in air or soil; and naturally the denser the forests and the higher the trees the greater is this influence. But if this question is incontrovertible, the same cannot be said of the influence of forests upon rainfall, &c.; an influence which is as often asserted as it is denied. Hitherto there has only been one series of observations giving comparable values and maintained a sufficient length of time, *viz., that in the neighbourhood of Nancy. These observations* indicate a considerable influence of forests on the increase of rainfall. The explanation appears to be that in winter the effect of forests upon rainfall should be unimportant in the climate of Central Europe—the difference of temperature and humidity between forest and field being very small, and the amount of vapour in the atmosphere inconsiderable. The observations, however, show that during this season the forests receive much more rainfall, &c., being accounted for by the following facts:—(1), In winter the clouds being at a lower level than at other seasons, the obstruction caused by the forest to the motion of the air must then considerably affect their motion; the air will consequently be forced upwards, and at a time of great relative *humidity a small ascent suffices to* produce condensation of the vapour. (2), In winter damp west winds are more frequent, and the rainfall is of longer duration; hence the greater importance of forest influence. In spring and early summer the effect of forests upon the increase of rainfall is much diminished, because at these seasons there is considerable evaporation from the surfaces of fields and meadows: probably more water evaporates *than from a given extent of field than from an equal* surface of forest, taking into account the evaporation both from crops and the soil. Towards the end of summer and the beginning of autumn the soil of the fields is considerably dried up, corn is ripe and evaporates but little, while the surfaces of the

leaves in the forests still evaporate freely. Conditions then are more favourable to an increased humidity of the air in the forests, their immediate vicinity, and hence to more copious and frequent rainfalls. Other kinds of condensation of vapour for which forests are especially favourable exist. In winter large quantities of hoar-frost collect upon the pine trees, which as the air gets warmer and damper soon falls, increasing the amount of snow on the ground. In warm and moist climates, especially in the tropics, dew collects so freely on the surface of leaves as to fall in large drops and wet the ground. In this manner a considerable amount of the water evaporated during the day returns again to the earth in the form of dew the following night.

Forests retain the water from rain or melting snow much better by the covering of dead leaves, mould and moss, and only allow a portion to run off superficially when larger quantities of water fall ; the remainder percolates gradually, and much of it *is utilized in evaporation from the trees. Although forests*, especially the dense luxurious forests of the tropics, cannot, of course, exist without a certain supply of water, yet the time when they receive it is of little import to them. A good instance of this is the Lencoran forest, on the west coast of the Caspian Sea, where vegetation is more luxuriant than in any other part of Europe ; for a mass of climbing plants encircles the trees so that it is always humid in the forest, and yet here the rain curve is a subtropical one, very little rain falling in summer, but large quantities in autumn and winter. The water is stored up in the forest, so maintaining evaporation during summer droughts.

In Upper Assam also, during the four months November to February, little rain falls, but the evaporation of the forests keeps the air damp. It would appear that the influence of thick forests of warm regions upon rainfall is such that, if the general climatic conditions are opposed to rain no rain falls, even where extensive forests exist. This is the case when the wind is constantly descending, or blows from cooler and dryer quarters—as from November to February in Assam, when north-east winds prevail. If there is a strong wind from warmer *and damper quarters, and especially if it has* an ascending motion, the conditions are favourable for rain, whether forest, field, or steppe predominates. Weather types are very far from being always so strongly defined. Frequently, in the vicinity of the Equator, the winds are variable or local ; or calms prevail. Under such conditions dense forests must be favourable to rainfall for offering an obstacle to the wind's movement ; they cause the air to ascend ; since it is already damp, condensation ensues. With the same direction of wind there would be little or no rain in woodless regions. During calms and clear weather, after a long drought, the ascending current over forests is much more humid than that over unwooded districts

where the ground is dried up, and vegetation withered. Here then are conditions again more favourable for rain production; in the former case even calms alone may cause rain with an ascending current; an example of this may be quoted in the case of the frequent afternoon thunderstorms in well-protected Alpine valleys. The correctness of the above remarks is proved by the frequent earlier commencement of rain in the tropical forests.

These considerations show that in the western portions of the Old World extensive forests materially influence the temperature of neighbouring localities, and that the normal increase of the temperature from the Atlantic Ocean towards the interior of the continent is not only interrupted by their agency, but they cause the summer to be cooler in regions situated further in the interior than those nearer the sea.

Hence forests exert an influence on climate which does not cease at their borders, but is exerted over a greater or less district, according to the size, kind, and position of the forests. Hence it naturally follows that man, by clearing forests in one place and planting others in another, may considerably affect the climate. Many incline to the idea that, as forests increase precipitation, it would only be necessary to plant in order to remove deserts from the earth's surface. A person familiar with meteorological questions will, of course, not assume such an extreme position. If the forest economizes rainfall, stores it up for a long time, and even to a certain extent increases precipitation, many parts of our earth are nevertheless too dry to support them, forest vegetation requiring much water. On the other hand, thin forests and such as consist of an excess of waxy trees, which diminish evaporation, are certainly able to survive in dryer climates than those consisting of trees closer together, which evaporate more freely; but the former have less effect in moderating heat and drought than the latter. On the other hand the widespread opinion that no forests can exist where none existed at the time of the appearance of civilized man is open to doubt. The success of forest culture in the Steppes of Southern Russia, the Prairies of North America, and the Pampas of South America sufficiently prove the untenability of this opinion. If afforestation has not hitherto assumed large dimensions, it is more as a question of economy rather than one of climate.

Other growths, such as corn, or the use of the land for pasture, &c., have been more remunerative to private individuals—human life being of but short duration as compared with that of trees.

If there be only a certain amount of rainfall, no matter at what time of the year it occurs, forests flourish. Even long periods of drought are much less injurious to forests than to meadows and fields; and the impossibility of forest culture in a

country is not due to the occurrence of rainless periods, provided that copious precipitation falls in other months.—*Timber Trades Journal.*

THE NORTH-WEST OF NEW ZEALAND.—An interesting pamphlet on the North-West of New Zealand as a new field for emigration has recently been published by Messrs. Bean, Webley & Co., of Foster-lane, Cheapside. The author, Mr. Alfred Cooke, Yarborough, says that he does not believe "there are fifty people in England who know anything whatever, definite or indefinite, of the present state of the extreme north-west of the colony." Regarding the culture of the olive and mulberry, both are said to be as yet only in their infancy, and it is to be regretted that the early settlers introduced wrong descriptions of both these trees, the result being that though the plants have grown well, and shot up into large trees, they are not adapted for the orchard, or for successfully rearing silkworms. On the subject of orange culture the necessity of securing a site which can be readily drained, and which is not too much exposed to the westerly winds, is pointed out. "A thoroughly good site of land for an orangery is a fortune to a man, while an unsuitable locality may be the means of causing irreparable failure. With a suitable site, and other favourable circumstances, the orange crop will pay four times better than any other crop; seventy trees should grow to the acre, and providing that the grower sells his crops at even 6*d.* per dozen (a very low estimate), a large sum per acre is obtained. A single tree in New Zealand has been known to yield 3,000 oranges. The vine, peach, and various other well known fruits, grow to perfection." The following account of Kauri gum from Dammara Australia will be interesting :—

The Kauri tree is described as the most valuable and finest trees in the Southern hemisphere, and from it exudes a soft gum, which hardens on contact with the atmosphere, and fossilises in the ground in the course of years. How long it may have been in the ground no one can say, but it is found on the sand hills where no trace of a tree remains, in the coal-beds, in a district where the Kauri tree does not now exist, and in large tracts of country from which evidently the forests have been in ages past burned from off the face of the earth. The discoloured condition of some of the gum dug up from several feet below the surface of the ground indicates that the trees were at one time exposed to the action of fire. The gum-fields are partly in the hands of the natives and partly in those of Europeans, but they are mostly the property of the Government, who have hitherto been in the habit of putting up to auction the right to dig gum on these fields. It is out of the power of a working-man to bid a lump sum for the right to dig gum

over an area of 20,000 acres of land for a term of two years, and the result is that the right of digging for gum falls into the hands of some merchant or storekeeper, to whom all who dig on the land are compelled to sell at a price fixed by the lessee. This method of leasing these lands is not by any means an equitable one. The first thing a gum-digger has to do is to purchase a spear—that is a piece of round iron pointed at the end, about 3 feet 6 inches in length, fixed into a wooden handle, this he can get on credit from the storekeeper—as likewise a spade, knife, some flour, sugar, and necessaries on the condition that he sells his gum to him. If the storekeeper is the lessee of the gum land this is a matter of course. Thus provided, the digger, proceeds to the gum field (a sort of moorland it would be called in England), builds a shanty of Raupo or Palm Fern, and commences to spear the country for gum. An experienced digger will know the likely spots for a good find, and can tell by the feel of his spear as it touches a hard substance underground whether it is gum, wood, or stone. If he thinks it is gum he digs it up, puts it in his kit or basket, and goes on. The gum as it comes from the ground is covered with dirt and rust, and every piece has to be scraped with a knife until the gum is fairly clean. A good deal of judgment has to be exercised in this matter, because if too much is scraped away the digger loses weight, and if not enough he receives a less price on account of bad scraping. Gum is also obtained in the forest from under the trees, and even from the tree itself. The best gum is very clear, like amber, and hard, but there are many sorts and varying prices. Though the average earnings per week of the gum digger is from £3 to £4, a man has been known to earn as much as £20. He has to work very hard, exposed to all sorts of weather, digging all day scraping his gum at night and cooking his meals between while.

The trade in Kauri timber is also very important, and gives employment to a large number of hands. The Kauri forests in the district are of very large extent, and it is stated, at the present rate of supply, will last about another 200 years. The timber is of very great value, and is recognised in New Zealand and Australia as most useful for all sorts of purposes—house building, shipbuilding, masts and spars, railway sleepers, furniture, &c. It is very durable, and easily worked. The tree grows to a height of 100 feet without a limb, and measures an average of 5 feet diameter. Trees have been found measuring a chain in circumference, but such trees are of no value to the purchaser, as they are too unwieldy to handle and cut up. In all Kauri forests there are found at intervals trees of enormous size, which stand alone in their grandeur as parent trees to the less unwieldy generation around them. In the forests the young trees grow readily, but so soon as the parent trees are felled and removed, a fire sooner or later clears the ground and they

perish. Altogether the Kauri is perhaps the most important tree in New Zealand.

The exportation of the fungus, *Hirneola polytricha* from New Zealand has frequently of late been commented upon. Mr. Yarborough speaks of it as a branch of industry only entered upon by children, who make a good deal of pocket money by it. The fungus is bought from the collector, after being dried, at prices varying from *4d.* to *5d.* per pound, and is exported *viâ* San Francisco to China to be used by the Chinese as an ingredient for soup. In 1882 the export of fungus was 400 tons weight, valued close upon £19,000.—*Gardener's Chronicle.*

THE TEAK MONOPOLY IN BURMA.—In continuation of the letter which I lately sent you for publication, I will now give particulars, as far as I can ascertain them, as to how the *row* originated between King Theebaw and the Bombay-Burma Trading Corporation, Limited. From what I can gather, that company had two distinct contracts with the King, which bore the following stipulations with regard to forest duty, say—

No. I Contract was for

	Duty per log. R.	A.
Dugyis, faultless logs, from $3\frac{1}{2}$ cubits and upwards in girth and 17 to 26 cubits in length, ...	10	0
Do. faulty do. do., ...	7	8
Do. do. under $3\frac{1}{2}$ cubits, ...	6	0
Do. faultless do. do., ...	6	8
Long loozars, $3\frac{1}{2}$ cubits in girth and upwards by 16 cubits in length, ... } *Short* do. 12 to 16 cubits, ... }	6	8
Yard pieces, $3\frac{1}{2}$ cubits in girth and upwards by 28 to 35 cubits in length, ...	16	0
Mast pieces, above 35 cubits in length, ...	30	0

No. II Contract was for

Lump sum of one lakh rupees, commencing August 1882 and running for five years from that date, covering logs under 3 cubits in girth—so called yathits—and short logs under 12 cubits in length—so called stumps—without stipulation as to girth. Now the Burmese aver that the Bombay-Burma Trading Corporation passed a number of logs under the No. II lump sum contract which should have gone under the No. I contract, thereby causing a loss of forest duty to the King, and this has been the cause of the row. The Burmese say that the out-put out of the forest showed the following results for the last three years, *viz.*—In 1882 out of 26,000 logs there were passed under contract No. I, 23,000 logs. In 1883, out of 33,000 logs there

were passed under contract No. I, 17,000 logs. In 1884, out of 42,000 logs, there were passed under contract No. I, 20,000 logs.

Probably before this appears in print, King Theebaw may already have been deported to a quiet corner in India, and the question may already have been decided as to whether it is to be annexation or a protectorate. That annexation pure and simple would undoubtedly be the best for the country is admitted by every one who knows anything about Upper Burma. Should annexation have been decided upon, Government should in all fairness to those engaged in the teak trade, make a most searching inquiry into the leases of the Corporation, and find out whether this firm did take any undue advantage under the same. If it is proved that the King has been done out of any duty really due to him, in such a case Government should confiscate all the logs now lying ready for removal in the forests and award no compensation whatever to the Corporation. I do not know in how far reports current a few years ago are true, and which were to the effect that the local Government constantly warned people going to Upper Burma to trade that they did so at their own risk, and that in case of any complications arising with the King at Mandalay the British Government would not recognise any claims. There can be no doubt that the Corporation were running great risks, and that they must have been aware that a hitch might occur some day. However, these risks were run by a company of merchants and traders whose seat is at Bombay, and who, to judge from the enormous dividends declared year after year, must have reaped most handsome benefits from their investments. This is matter for consideration, should it hereafter be found that the Corporation is entitled to some compensation. Whatever plan be hit upon after annexation, none could be better than that Government should at once place the whole of the forests in Upper Burma under the Forest Department. In no case should it be allowed that the Corporation remove any of the logs now felled, and it could readily be ascertained what compensation they should get for such logs. The Forest Department would be able to sell these advantageously either at Tounghoo or bring them down to Rangoon, where there would be more buyers. There would, of course, be some delay in getting the Forest Department to organise the proper working of the forests, but at present such delay would only be beneficial to those engaged in the teak trade, as just now the European as well as the Indian markets are glutted with the article, and a year or two of short supplies of logs would be a decided advantage to all concerned. As for allowing the Corporation to carry on their leases until they expire, such would never do, as by their monopoly they would kill all the free trade in teak at Moulmein and ruin no end of people who have for a long number of years

existed by it. It stands to reason that Government should give the preference to the interests of the large community, and not favour at their expense a trading company whose shareholders have no other interest in Burma. The old saying might here be fitly applied: The flock and not the sheep ought to be the shepherd's care."—TECTONA GRANDIS.—*Pioneer.*

UPPER BURMA AFFAIRS.—Since writing my last letter to your paper recently, matters in Upper Burma have progressed rapidly, but although Thoebaw has been deposed no positive declaration has as yet been made whether the country is to be annexed or not. The state of things now created shows more and more every day that the only proper course is annexation: not only will such be hailed by the bulk of the peaceful inhabitants, but it will also once and for ever settle the matter, and above all become within a *reasonably short time a great benefit to trade.* Of what benefit could a puppet king be is a question which has already been discussed and dismissed as one unworthy of consideration, and which in the end might prove unpleasant when the military energies of England will all have to be concentrated elsewhere. There should be no half-measures, as such would not be any improvement upon the state of things which existed during the reign of King Theebaw. Lately there have been strange rumours as to the utterances made by *well-informed* Government officials as to the value of retaining Upper Burma, and they are *said to have come even to the conclusion that the* likely revenue and expenditure would leave a deficit on the administration of that country for some years to come. On making inquiries as to how such estimates were arrived at, it was found that for the forest revenue only $4\frac{1}{2}$ lakhs of rupees had been put down. This shows at once how unreliable this estimate must appear in the eyes of those who have any practical knowledge of the country. This sum is not more than the Bombay-Burma Trading Corporation hitherto paid to the King of Burma! Everyone knows that it was never intended that they were to get the timber so cheap, *and that they had to pay large sums in* the way of incidentals. Does Government intend to favour the Corporation and let them have the teak logs at the price of firewood? I should say such is the inference which must be drawn from the foregoing estimate of forest revenue. Let us, however, deal with what can be done by the Forest Department in the near future. Making a rough estimate of the logs which during the last few years have been worked out of the forests in Upper Burma, and allowing for an improved system under the Forest Department, at least 100,000 logs of decent sizes should be worked out annually, *and taking these at an average value* of Rs. 50 each, and deducting Rs. 10 per log for working expenses,

there should be left 40 lakhs of rupees for forest revenue, and which is irrespective of other forest produce, such as kutch, caoutchouc, sticklac, &c. Surely such a revenue under one head alone is not to be despised, and there are other sources of revenue which will also in time become important. Some time ago I saw it stated in one of the leading Indian newspapers that Mr. S. G. Jones, the Manager of the Bombay-Burma Trading Company, had been requested by General Prendergast to accompany the head quarters of the expedition to Mandalay, and left for Thayetmyo on the 13th November, to give information, and probably to hasten movements. General Prendergast stated in his proclamation that war was being made for the sake of the Corporation, but the foregoing is another favour bestowed on that Company, and from it it infers that they are to be allowed to go on at once with their forest operations. This should not be allowed until a most thorough inquiry has been made and a proper decision arrived at as to whether that Company took any unfair advantage of the late king or not. To assert and to prove are two different things, and it would certainly be a most crying shame to allow an *ex parte* decision in this very important matter. It will never do for Government to allow it to slide, and the sooner the investigation takes place the better. As has already been published in several newspapers, the Corporation have secured some very extensive contracts for teak required for barracks, &c., in Upper Burma, which were given out without any tenders having been invited, thus ignoring entirely the other owners of saw mills at Rangoon, and the more numerous ones at Moulmein, who may have been able to supply the timber on cheaper terms. This does look as if in the eyes of Government the Corporation are the acknowledged monopolists of teak, and that other firms in the trade count for nothing. Mr. Bernard has not yet shown that he is the friend of Moulmein, and certainly in this case he would appear to be the one of the Corporation. Free trade and no favour should always be the motto of Government.—*Pioneer.*

FORESTRY.—The report of the proceedings of the Select Committee on Forestry which sat during the past summer does not, perhaps, throw any more light on the condition of forestry in this country than was possessed before the appointment of the Committee, for the substance of the evidence given is for the most part to be found in the various works and reports on forestry that have appeared from time to time during the past few years; nevertheless the evidence of such men so well versed in forest conservancy, especially with regard to India, as Dr. Cleghorn, Col. Michael, Col. Pearson, and Mr. W. G. Pedder is of much value, as it brings together in a collected form information that has hitherto been much scattered.

The subject of forest produce is one that is but little understood or even thought of by people in general. It is supposed by most people to relate only to the supply of timber, which indeed of itself is of very great importance; but when we consider the other products—such as gums, resins, oils, fibres, and such like—the enormous money value becomes more apparent, as well as the great importance of the forests as sources of many absolute necessities of life. The evidence of Col. Michael fully illustrates this, and is especially valuable from this point of view. Taking the subject of Indian timbers alone, the value of teak was fully set forth when it was shown to be unequalled for the backing of ironclads and for ship-building generally, as offering the greatest resistance of any known woods. Questioned as to whether teak was capable of being brought into this country as a commercial article at a remunerative profit, Col. Michael replied that, judging from the price realised for some logs sold at the Forestry Exhibition at Edinburgh and from other information obtained, no doubt existed that the trade in teak might become a very remunerative one. It was shown further that in 1883 £647,000 worth of teak was imported into England; but Col. Michael also touched upon what, if put upon a proper footing, might equally, or perhaps more so, become a source of revenue to India and a boon to this country—namely, the introduction of the more ornamental woods for cabinet purposes. There is, of course, always a steady demand for British-grown timbers such as oak, elm, ash, maple, &c., but these have to be supplemented by foreign woods of a more ornamental character, and of these mahogany, rosewood, ebony, satinwood, and such like are the best known. From amongst Indian timber trees a long list might be made of woods which are now almost unknown out of their native country—such, for instance, as the East Indian cedar (*Cedrela Toona*), which is a reddish-coloured wood with a splendid wavy or feathery figure; the tree is also found in Australia, where the wood is highly valued; the padouk (*Pterocarpus indicus*), the deep-red-coloured wood of which attracted so much attention at the Edinburgh Exhibition last year; the Malabar Kino tree (*Pterocarpus marsupium*), also a finely-marked deep-red wood, several species of *Terminalia*, durable woods of a brown colour with darker brown markings. Many others might be mentioned, but the most beautiful of all the Indian woods for its ornamental character is the Chittagong wood (*Chickrassia tabularis*). This is of a brown colour, with transverse lighter silvery-brown wavy markings, which impart to it a varying depth of light and shade, which, when polished, imparts a peculiar and charming lustre. All these woods take a high polish, and would be invaluable for cabinet-work. Fine specimens of these and many others are in the collection of Indian timbers exhibited in the No. 3 Museum at Kew.

On the question as to the durability of the Scotch fir (*Pinus sylvestris*), Col. Pearson gave an opinion which is worth quoting. He says:—"I think myself that as the value of the foreign imported timber increases, as it must do as the quantity diminishes, people will come to appreciate more the Scotch fir, because I know many barns which have been boarded with Scotch fir for twenty years, and which are standing perfectly well: but it is convenient to get the imported boards ready sawn out, and where the people can get them cheap they do not pay attention to the Scotch and home-grown timber. But, speaking for myself, I should say that Scotch fir is a perfectly good wood as long as it is sufficiently mature, and I think, as foreign wood becomes dearer, as it will in a few years, English timber and Scotch timber will become of a value which it has not now."

On the general subject of the proposed Forest School Col. Pearson expressed himself in favour of a Chair of Forestry at the Edinburgh University, but he further stated that he had no actual faith in lectures in the school unless illustrated by practical instruction. "If," he says, "you tell a man in the lecture room that such and such consequences will take place, and do not show him the consequences on the spot, he does not believe anything about it; it goes in at one ear and out at the other; he will think it all nonsense; but if you want to impress your teaching upon him, you must take him out into the forests and show him the operations of Nature." Regarding the extent or scope of the School, Mr. Thiselton Dyer, in reply to Sir Edmund Lechmere whether he would not make the School of Forestry applicable to India and the Colonies as well as to our own country, said, "I should like to get all the fish possible into the net, and if we had such a school, to make it as useful as possible. I think it is surprising, considering how large is the interest of the English race in forestry, that except in India we have taken no kind of active interest in the subject: although we own more forests in the world than any other race, we are at present, except in the most piecemeal fashion, absolutely washing our hands of the whole business." Mr. Dyer, in his evidence, further pointed out by way of illustration a few of what are usually called the minor industries of forest produce, which in the aggregate become of considerable national importance.

It is to be regretted that the Committee was not nominated at an earlier period of the session. The first sitting was on July 14, and at the two subsequent sittings on July 21 and 24, witnesses only were examined. The report of the Committee refers to the impossibility of concluding their investigations during the Session, and "recommends that a Committee on the same subject should be appointed in the next Session of Parliament."—JOHN R. JACKSON.—*Nature*.

CERTAIN planters of the Nilgiri district have been much exercised with regard to the cheap sale of firewood by Government to the detriment of private enterprise, and have addressed a petition to the Governor of Madras, protesting against the action of certain Government officials in this respect. Their complaint appears to be—

(*a*). That the Forest officer of the Nilgiri district takes contracts for the supply of firewood at low rates, lower than have prevailed for 40 years—and that he has taken a contract to supply dry wood at Rs. 67 per ton.

(*b*). That in order to obviate the extinction of the planting enterprise, Government must "prohibit its officers from taking contracts for the supply of firewood, and selling wood to private parties," and confine them to the supply of "Government brick-fields and other kindred requirements."

The Collector of the Nilgiris is of opinion that some of the signatories of the petition are engaged in planting firewood trees for sale to the public, but that the majority have only sufficient for their own requirements; and that by the retirement of Government from the field, the price of firewood would be raised so high as to cause serious hardship to the poorer consumers. Looking, therefore, from the consumers' point of view, the participation of Government in this enterprise can only be looked upon with satisfaction. On the other hand, however, the petitioners say that "there is now a considerable amount of wood available for the public," and it may be inferred that if Government enters into competition with them, private enterprise must go to the wall. It further appears that sixteen persons obtained allotments of land aggregating 506 acres in 1869 for fuel plantation, and it is to these grants that the petitioners refer. The Collector, however, points out that the land of fourteen persons, representing 428 acres, has been resumed, in consequence of the grantees having failed to plant it; and that only two persons retain their land to the extent of 77 acres, and that even in these the planting has been imperfectly done. Under these circumstances, the Collector upholds the participation of Government in this enterprise, and denies that the rates have been unduly lowered. To our mind, the petitioners have failed to make out a strong case. If they have neglected to utilise properly the land granted to them, they cannot expect the consumers to submit to pay high rates, when, by Government stepping in, they are enabled to buy firewood, at cheaper rates. The Government of Madras have, however, taken a more liberal view, and after consulting the Conservator of Forests, have issued the following order, which should meet the case on both sides:—

The Government observe that large State forests are main-

tained in this country for reasons of paramount importance to the community. The thinnings and loppings of these forests must be disposed of somehow, and there does not appear to be any difference in principle between selling such cuttings wholesale and selling them by retail. The Government concur, however, in the opinion expressed by the Conservator that for reasons of departmental convenience, it is desirable to substitute sales on the plantations, if possible, for the existing system. They resolve, therefore, to direct that for the present the system of sale at the Government depôt be maintained with the modification that deliveries at houses should cease, but that after November 1st the cuttings on plantations and sholas, in compartments to be set apart for the year, be sold by auction in the manner proposed by the Conservator. Should this experiment prove successful the depôt will be closed, but a reserve of one thousand tons should still be maintained ready for sale, in case the artificial advantage now to be conferred on certain private growers should result in an undue raising of the price of fuel to the prejudice of the poorer classes. The issue of tickets for head-loads to bazaar purchasers will continue as at present.—*Indian Agriculturist.*

BECHUANA LAND.—This newest colony of "Bechuana," or whatever its ultimate title, lies in the heart of temperate Africa. Its official limits are "the parts of South Africa situate west of the boundary of the South African Republic; north of the colony of the Cape of Good Hope; east of the 20th meridian of east longitude; and south of the 22nd parallel of south latitude." It is situated on the great central backbone of Africa, and is for the most part a plateau of from 4,000 to 6,000 feet above the sea level and healthy to a degree for Europeans, a feature incontestably proved by the medical records of General Warren's expedition. Entering the district from the south, the general character of the country is that of open and undulating plains, for the most part bare of forest trees, but dotted with patches of camelthorn scrub. This lasts for about 100 miles, after which the country becomes pleasantly and at times densely wooded, except when it is mountainous, as in the neighbourhood of the "stony" towns of the chiefs Gasseitsi and Sichele. The main cause of this absence of trees lower down is the enormous demand for wood created when the diamond diggings made Kimberley a populous centre, using endless steam engines. It is commonly reported that for 10 years every day there entered Kimberley about 100 wagons, each carrying on the average 20 trees, chiefly cut up in these districts. Coal during this period was from £14 to £18 per ton. It is hoped that this indiscriminate wood-cutting will be stopped by the new administration; at all events, it will not proceed at the same rate now, inasmuch

as the completion of the railway to Kimberley will reduce the price of coal by a third, and make it as cheap as wood fetched from necessarily long distances. This absence of wood or danger of its absence must be rectified, or the conveniences of life will be much curtailed. At Khanza, the town of the Bamangketsi tribe, and again at Sichele's Town, the Missionaries have planted trees in their gardens; and although these are not 12 years old, I found very flourishing and well-developed specimens of blue-gum, apple, pear, peach, cherry, vine, loquat, fig, pomegranate, mulberry, quince, orange, lemon, citron, banana, and others.—*Times.*

CASUARINA TIMBER.—In your issue of Saturday last, you referred to a letter from the Honorary Secretary of the Madras Agri-Horticultural Society to Mr. Thorowgood, Chief Engineer, Madras Harbour Works, suggesting that casuarina timber might be utilised otherwise than by being used for firewood, particularly by being set on end as blocks for paving level crossings over the Harbour Works Railway. Mr. Thorowgood has acquiesced in the desirability of giving the suggestion a trial. The results of the experiment will be eagerly awaited by a large class of men who are proprietors of casuarina plantations. The result will also be of interest to professional men. The industry of casuarina planting in Madras is so profitable, and its rearing requires so little care, that every acre of available land bordering on the seashore is now being planted out by the owners with casuarina. And if scope is found for its use in any new direction it will give an additional impetus to this industry. But, as Mr. Thorowgood has remarked, casuarina wood will not stand the change from wet to dry. It is liable to rot under less unfavourable circumstances than teak wood, and other equally expensive timbers of India. One of the chief requisites of paving materials is durability, immaterial of cost, for it is undesirable to renew the material more frequently than is absolutely necessary, as it blocks up traffic during repair. I cannot, therefore, be very sanguine of the success of casuarina timber as a paving material. But there are other uses, which have not occurred to many, to which casuarina timber may be put in positions where their strength and durability will not receive such a severe test as in a level crossing.

The idea of cutting casuarina logs into planks and reapers has not yet suggested itself to builders in Madras. But this idea was profitably availed of in a large tile factory on the Western Coast, where it became necessary to devise some plan for manufacturing with as little expense as possible, shelves to a large extent for drying the tiles under sheds. An experimental attempt was made to saw some casuarina logs into planks

and reapers. The results were as gratifying as they were surprising. The logs yielded planks one inch thickness and one foot in breadth. Several hundred drying shelves were manufactured with such planks and reapers. Casuarina reapers were also used for the roofs of the sheds. The saving effected by the employment of casuarina wood, in lieu of more expensive timber, was considerable. The difference of cost in Madras will be greater still, as casuarina is an indigenous plant of the Coromandel Coast, while all other timber has to be imported from Burma, or the Western Coast. It is the usual practice in Madras to fell casuarina trees, intended for firewood, long before they attain the proper age of maturity. There is a certain age at which each tree reaches its greatest weight, after that, the trees loses in weight, but gains in strength and durability, until the age of maturity is reached. To dealers in firewood, strength and durability are of less consequence than weight. Hence trees are sometimes cut almost green. Timber obtained from such trees lacks strength and durability, and is liable to split during the desiccating process. It is also prone to be attacked by white ants, and is susceptible to the effects of damp. In Madras, seven years are considered sufficient for the full growth of a casuarina tree. The timber used for the shelves mentioned above was obtained from trees at least 15 years old, and, when seasoned and sawn, they presented a brown colour deeper than that of benteak. If it is desired to utilise casuarina wood for like purposes in Madras, the trees must not be felled until they attain the full age of maturity, which, from the above experience, may be fixed at not less than from 12 to 15 years. Casuarina, used as fuel, is obtainable in Madras from Rs. 10 to Rs. 12 per ton. But taking into consideration the longer growth of trees, intended for building purposes, the cost of the timber in square logs may be set down as Rs. 25 per ton. The least expensive timber procurable in Madras is mangoe wood. It costs about Rs. 50 per ton. Casuarina wood will, therefore, not be half as costly as the least expensive timber procurable in Madras.—H.

With reference to a letter on casuarina timber signed "H," published in the "Madras Mail" of 14th instant, I think your correspondent is mistaken when he says that the idea of cutting casuarina logs into planks and reapers has not yet suggested itself to builders in Madras. Many years ago I heard that Messrs. Deschamps and Co. had constructed the roof of their pianoforte warehouse of casuarina timber; and a Royal Engineer recently told me he had used it to some extent for rafters and reapers, and other inside work, in out-buildings, and it served his purpose well. Wherever roughly sawn timber will suit the work, certainly where not exposed to the weather or to the attacks of white-ants, casuarina wood might profitably be used;

but where finish is necessary, its extreme hardness will make it too expensive to work, although I have seen some excellent articles of furniture made of it. Your correspondent is also in error in his belief that, in Madras, seven years are considered sufficient for the full growth of a casuarina tree. It is true that planters on a small scale, and certain persons who wish to make a show of returns, cut their trees at even five years old, but persons who can afford to wait, and who have well weighed the subject, think that the maximum of profit for fuel is probably attained when the trees are between 15 and 20 years old, though the trees grow long after even the latter age. Certain it is that there are hundreds, and probably thousands of trees in the plantation near Madras of about 15 years old and upwards, from which might be cut long and straight planks of a foot broad; and probably the owners would sell them standing for the purpose at half the sum of Rs. 25 per ton which "H" reckons as their value.—*Madras Mail.*

In the island of St. Helena, the white ants were, it is supposed, accidentally introduced from the coast of Guinea, about 20 years since. Jamestown was devastated, the cathedral and the books of the public library were destroyed. Everything in the town made of wood was more or less injured, imperilling the lives of large numbers of the 4,000 inhabitants. In the Government stores it was found that the moist traces of the insect on the outside of the tin cases caused very speedy corrosion of the metal, and enabled the insects to make their way in and devour the contents, doing many thousand pounds damage. The Governor of St. Helena applied to the Lords of the Admiralty for the best mode of finding the ant's nests, and effectually destroying them, and also as to the description of timber which has proved to be least susceptible of injury from the insects; these inquiries having been referred to General Hearsey and the Entomological Society, it was decided that the nests must be sought in the plains, that if the ants once effected a lodgement in the walls of a house, the walls themselves must be taken down before the insects could be got rid of. Steeping timber in a solution of quick lime, will prevent the attacks of the insects, and impregnating the timber with creosote has been found a preservative. In Western Australia, where white ants abound and destroy all buildings and furniture to a great extent, the wood of the mahogany tree has been found proof against the ant's attacks: while in the Amazon country, where the house walls consist of posts with crossed laths filled up with mud and covered with lime and cement, the houses, if washed over with a solution of arsenicated soap will be preserved from attack.—*World of Wonders.*

NEW TANNING MATERIALS.—We have received from Messrs. T. Christy and Co., of 155, Fenchurch Street, a sample of some finely-ground bábul pods (*Acacia arabica*). The sample is of good quality, giving as much as 31·88 per cent. tannic acid. We had previously analysed several samples of these pods, but they were all with the seeds enclosed; and as the seeds were very large and heavy, we advised our correspondents to pick up the pods when quite ripe, so that the seeds might be easily removed, thus lessening expense in freight and rendering the material more valuable. In this instance it has been done, and will, we believe, pay the shippers. Our friends would do well to communicate with Messrs. Christy and Co., who state that a shipment is *en route* and may be expected shortly. The bábul bark is in common use with the tanners of Hindustán and other countries; in some cases they use nothing else. The supply is unlimited, and as it is without doubt one of the finest forms of tanning, we trust some of our readers will go out of their way to try this new material, and not allow it to lie neglected at the docks. The colour it imparts to the leather is lighter than oak bark. We need hardly say that we shall always be prepared to encourage the import of any new material. If samples are sent to our office, our laboratory will be open to receive them and report thereon.—*Leather*.

THE trees may outlive the memory of more than one of those in whose honor they were planted. But if it is something to make two blades of grass grow where only one was growing, it is much more to have been the occasion of the planting of an oak which shall defy twenty scores of winters, or of an elm which shall canopy with its green cloud of foliage half as many generations of mortal immortalities. I have written many verses, but the best poems I have produced are the trees I planted on the hill-side which overlooks the broad meadows, scalloped and rounded at their edges by loops of the sinuous Housatonic. Nature finds rhymes for them in the recurring measures of the seasons. Winter strips them of their ornaments and gives them, as it were, in prose translation, and summer reclothes them in all the splendid phrases of their leafy language.

What are these maples and beeches and birches but odes and idyls and madrigals? What are these pines and firs and spruces but holy hymns, too solemn for the many-hued raiment of their gay deciduous neighbours?—OLIVER WENDELL HOLMES.

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FOREST ORGANIZATION FOR BEGINNERS.

(*Continued from page 56*).

SECTION III—ASSESSMENT—(*continued*).

C.—Methods of estimating the cubic contents of groups involving no diameter-measurements.

V.—By Eye.

In estimating the contents by eye, the assessor walks through the group from end to end in several directions and estimates either the contents of each tree singly, or the contents per acre of the whole at a glance, from experience of the cubic contents per acre of trees growing under similar conditions of height, age and environment. In the latter case, he has to make allowance for blanks. If each tree is estimated singly, the assessor has to mark every one as he proceeds with the bark-blazer, or with paint, so as not to estimate the same tree twice.

Even when carried out by men of long experience, estimates of this kind may differ from the actual quantity by 50 per cent. or more. The method should not, therefore, be employed for seedling-forest in any case in which a certain degree of accuracy is essential. It may, however, sometimes suffice in estimating the contents of young seedling-groups which are not destined to be exploited during the current period (of, generally, 10 to 20 years), and also for estimating the yield of coppice-forest. In the former case, the question will generally be not so much what the present yield of a group is, as what it will be at the end of its revolution ; but this is a problem which cannot be solved for many years in advance, fortunately a rough estimate is all that is generally needed in such cases, and much less accurate methods will often suffice than are necessary, or desirable, in the case of maturer groups.

VI.—By means of Experiential Tables.

Experiential tables consist in tabular statements showing the yield per acre of a species from year to year, or from period to period. Besides being useful for estimating the contents of unmixed groups, they may be employed in a variety of ways for other useful purposes, as, for instance, in the determination of the most advantageous revolution, in fixing the current, past, and prospective increment, as well as the quality-class, of a group as measured by its yield at any given stage of its growth. In valuing forests for purposes of taxation, commutation of rights, &c., statistical data of this kind are indispensable for the solution of certain problems.

It is desirable that they should contain columns showing, at least, for various average ages, (1), the yield per acre of main-cuttings, and (2), the average height. To this may be added, if required, information regarding (3), the yield of thinnings per acre, and (4), the aggregate basal area per acre. The sum of basal areas is not necessary for determining the cubic contents of groups by this method, but it may be used to determine the quality-class of a group. It is usual to have four or five such classes, each one corresponding to certain yields per acre according to their yields from period to period, and if it is found that the trees on a test-plot in a group whose class we wish to fix, is about 50 years old, with an average height of 60 feet, an aggregate basal area amounting to 150 square feet per acre, and that these quantities correspond pretty closely to similar data in the tables for a group of, say, the best class, then it may be taken for granted that the yield per acre is about the same in both cases, and that, consequently, the quality-class is also the same.

A question which has sorely troubled compilers of tables is how to fix the class which shall correspond to a given yield. The usual method pursued until comparatively recent years has been to select fairly well-stocked groups of various ages from amongst the worst, to measure them after thinning, and to give the average results per acre as the yields of the first class. The yield of the best class is similarly determined. The yields of intermediate classes are then determined arbitrarily, to the best of the assessor's ability, by examining groups which he thinks are of the required quality, or they are interpolated in arithmetical progression between the best and worst yields. Of course, it would not be possible, nor indeed expedient, to determine the volumes of groups of every age from year to year by actual measurement; groups of very different ages (16, 21, 30, 36, 45, 51, 60, 68, 75, 83, 91, for example) are therefore, taken for experiment, and the yields of intermediate years interpolated arithmetically. In the tables, the yields are then shown at regular intervals of 5 or 10 years.

The following method, which is certainly one of the best, was

first employed by Baur when constructing tables for beech and spruce. A number of groups of all ages and classes in various parts of the country, or tract, for whose forests tables are to be constructed, are selected, endeavour being made to take as nearly as possible the same proportion of good, medium and bad groups, and to avoid abnormally good, or bad, ones. They should be fully stocked, and the test-areas not less than three-quarters of an acre each, nor should less than 30 such plots be taken for each class, or, supposing that five classes are decided on in any case, 150 altogether. If any require thinning, they should be thinned to the usual extent. The remaining trees are then measured to test the yield of main-cutting: the quantity of timber and firewood, the mean heights, ages, and coëfficients, and the sum of basal areas, being ascertained (by Draudt's method) for each test-plot. The station and condition of each group are also described. The average yields, &c., per acre are then deduced from the above data. The increment in height during the past five years is also determined for each test-group: this information is required for determining the height-curves. The operator may then proceed to determine the cubic contents for all ages graphically. For this purpose, a straight line (abscissa) is drawn parallel to, and near the bottom of, a sheet of paper, and divided into as many equal parts as there are years in the average age of the oldest group. The divisions, representing one year each, are numbered successively from left to right, and lines (ordinates) drawn at right angles to the abscissa from them to the top of the paper. The cubic contents per acre of the experimental groups are then marked off on the ordinates on a suitable scale, from points on the abscissa corresponding to their respective ages. The number of cubic feet in any group corresponds to the length representing that group's ordinate, the distance being marked off by a dot, or circle, which should be numbered so as to correspond to the number of the experimental group.

To determine the limits of the classes, the highest points on the ordinates are all joined together in one line, and the lowest in another line, both lines meeting in the year 0 of the abscissa, as shown in the diagram. These lines represent, respectively, the highest and lowest limits of the classes. The positions of intermediate class-lines are fixed by dividing the portion of the last ordinate which joins the two class-lines, into a number of equal parts answering to the number of classes required. If there are to be five classes altogether, four distances will have to be inserted. Curves are then drawn joining each of these points with the point 0 of the abscissa. In drawing out the first two lines, an angular zig-zag arrangement should be avoided, a gentle curve being maintained, which will sometimes pass above, and sometimes below, the points they should intersect. In this way abrupt variations, which are not natural, are elimi-

nated, and a more average result is obtained. If any of the test-groups are found to be represented by strikingly long, or short, ordinates, they should be left out of consideration altogether in drawing the curves, the object being to avoid extremes. The spaces between the lines represent the ranges of the classes; The groups whose ordinates terminate in the second space from the top belong to the third class, for instance, supposing there are four classes.

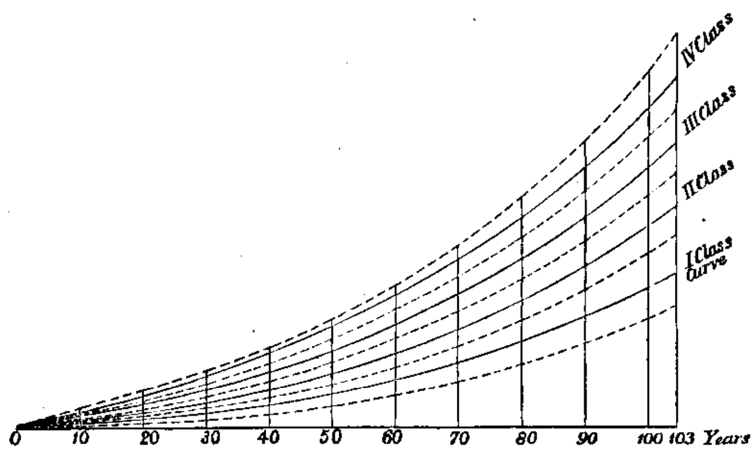

Figure illustrative of the graphic method of finding the cubic contents of groups—for four classes.

The average cubic contents of a class will then evidently be found by drawing a curve through its centre from the last ordinate to the point 0. The average cubic contents of a group 50 years old of the 4th class will, therefore, be found by measuring the length of the ordinate number 50, to the top continuous curve, that length on the scale being the equivalent yield in cubic feet of an average group.

The other data which have been collected, may also be regulated by means of a system of curves. Baur found that the average heights always correspond to the class to which a group belongs, and that the heights are, therefore, at once the simplest and most reliable means of ascertaining to which class a group belongs. The truth of what Baur and others consider they have demonstrated by direct experiment may be shown to be probable in another way. Extensive experiments seem to have proved, for instance, that if the average ages and heights of two groups, of the same species and similar as regards density and treatment, be the same, their form-coëfficients will also be equal; but if the heights, ages and coëfficients of two such groups be equal, the remaining factors on which their volumes

depend, namely their basal areas, must also be equal: consequently, their quality-classes must be the same.

Baur employs a somewhat different method, for finding the average heights, to that just described for finding the cubic contents of groups. He lays off the heights, in the same manner as the cubic contents are laid off, on ordinates: those of test-groups which are first class as regards their cubic contents are represented in the ordinates by black circles, or dots, those of the second class by blue, those of the third by yellow, and so on, each class getting a different colour. In every case it will, he says, be found that the heights of the first-class test-groups are arranged together in one row, those of the second in another, and so on in ascending order up to the best class, each one having a distinct zone of its own. He then reduces the number of these scattered points (in each zone, of course, separately) by taking one average height for clusters here and there, where convenient, indicating the central position of each one by a cross. The crosses in each zone are then joined in the manner already described by means of curves, which represent the average heights of groups for corresponding ages and classes.

In estimating the heights of the crosses, that is to say, the average heights of the clusters, their heights must first be reduced to one age, when the mean of the whole number may be taken as the required height. Thus, if a number of groups taken in a cluster vary in age from 90—102 years, it would suffice to reduce their heights to those corresponding to an age of 96, which is the mean between 90 and 102. For a test-group 91 years old, in that case, an increment of 5 years would have to be added to its height: for one of 97 years, one year's increment would have to be deducted, and so on, which can easily be done, because the height-increments of test-groups being known for the past five years, and the same rate being assumed correct for five years to come, ten years' increment may be said to be known for each group. The average of the reduced heights would then give the average height of the cluster for an age of 96 years.

Hitherto it has been generally assumed, in theory at all events if not in practice, that experiential tables should only be employed for determining the contents of groups which are well-stocked, and which have received the same treatment from youth upwards as those which were used in compiling the tables. Baur, however, claims for his method that it gives results which may be safely applied to groups irrespective of their previous treatment, and density, provided that very great accuracy is not required. In order to determine the contents of an incompletely-stocked group, it may be necessary to make allowance for density: if, for instance, the density of a group is estimated to be only ·7, the yield shown in the tables for a fully-stocked group of the same quality would have to be multiplied by ·7.

In order to find the quality-class of any group, that of the group in the tables most nearly corresponding to it as regards height and age should be taken as the required class. If, for instance, a group is 60 years old and 70 feet high, and if a group of the best class of that age should, according to the tables, have a height of, say, 72 feet, the group in question might be considered to belong to the best class; if, on the other hand, its height were, say, only 60 feet, it would belong to a lower class.

One of the principal uses of tables of this kind is to enable the organizer to predict the rate of growth of groups. In estimating the yield of a group which has to be exploited, say, 20 years hence, it is necessary to add the prospective increment during that period to its present contents, so that the most elementary system of management may require the construction of increment-tables, as they are sometimes called.

The following table of the yield of spruce of the best class was constructed by Baur by the method of curves. He gives also the yields and other particulars for four inferior classes, as well as columns showing the aggregate basal areas per acre, which are not given here, the amount of detail which is given being quite sufficient to illustrate the method.

TABLE OF YIELDS PER ACRE FOR SPRUCE: BEST CLASS.

Age of Group.	Mean height of Group.	Cubic Contents.	
		Timber only.	Timber and other Wood, including Branches.
	Feet.	Cubic feet.	Cubic feet.
5	1	..	215
10	3	72	572
15	8	501	1,140
20	14	1,001	1,959
25	24	1,616	2,889
30	34	2,604	3,947
35	42	3,232	4,948
40	50	4,276	5,892
45	56	5,234	6,793
50	62	6,078	7,523
55	67	6,807	8,165
60	72	7,465	8,809
65	77	8,108	9,395
70	82	8,680	9,967
75	87	9,252	10,482
80	92	9,824	10,982
85	95	10,386	11,483
90	98	10,897	11,983
95	101	11,397	12,470
100	105	11,898	12,899
105	108	12,341	13,328
110	111	12,427	13,757
115	113	13,085	14,157
120	115	13,442	14,515

Remarks.

The current yearly growth in height culminates in the 40th year.
The mean height-growth in the 77th year.
The current cubic increment of the timber and firewood culminates in the 67th year.
And their mean yearly cubic increment in the 116th year.

(To be continued).

(To be continued).

LIGHT GRAZING IN GOVERNMENT FORESTS; SOME CAUSES INFLUENCING THE REPRODUCTION OF FOREST TREES.

Given that the number of cattle is great in the neighbourhood, but that they have already a reasonably sufficient grazing area for their purposes, what will be the effect of opening, for a few months of every year only, forest tracts at other times closed to them? This is the question in so far as the Bahraich Government forests are concerned, of which a very extensive area is kept open to pasture from year's end to year's end. Let other officers formulate in accordance with the conditions special to their districts.

Let no man generalize in a matter subject to so many extreme differences of treatment as a forest. Seeing that the same forest will very often require a totally dissimilar treatment at our hands for its component parts, the folly of suggesting a uniform *régime* for a collection of districts becomes manifest; but what about the folly of that suggestion when intended to include several Provinces!

Surely an officer making recommendations of the kind, recommendations known to be acceptable to Government for many just and unselfish reasons, exposes himself to be regarded with well-warranted suspicion.

Would the opening of the closed tracts of the Bahraich forests for a limited period of the year only have all the effects which the advocates of "light" grazing claim for such a course? It is as well to remark here that those who propose this subdued form of grazing are apparently, themselves, alive to the evils of "heavy" grazing, since they all carefully make the above distinction of "light" grazing.

Evidently then, they only claim for the less severe condition that the evils *necessarily* attendant on the presence of cattle are here compensated for by advantages and benefits which the total exclusion of cattle precludes.

Assuming that this subdued form of grazing is practically possible, I am willing, under certain special conditions of forest, to admit the truth of the above assertion. But only so long as this "light" grazing is confined to the tract of forest requiring this special treatment, and is discontinued when the object sought

for has been accomplished. In most instances, I should be inclined to seek for a less dangerous remedy. There can be no possible doubt that, under certain conditions of forest, the result of excluding fires and cattle is of the most disappointing nature.

Absolute failure of reproduction will, in almost every case, be due to some unfavourable state of the soil. The Bhinga forest in Bahraich is a notable instance of the kind. This sál forest has, in parts, been strictly preserved during the past 10 years. Yet, you may walk a mile in those closed tracts, without, on diligent search, finding more than half a dozen sickly seedlings, most of which would appear to die off within the year. An examination of such parts of the Bhinga forest as are still open to cattle—a very large area indeed, comprising as it does two-thirds of the forest—will give us a good idea of what the closed tracts were previous to having been reserved. The whole of this open forest is much grazed over, so much so indeed that at *the close of the rainy season there may be said not to grow on* its surface a blade of grass 2 inches long, unless indeed within the protecting influence of some thorny shrub or creeper. So much is this forest grazed over, that it is only through fear of soon having no timber wherewith to supply the neighbouring privileged populations, in view of the certain ruin of the rest of the forest, that we have been induced to close any part of it to cattle. Constant felling—if only of inferior species—unattended by a corresponding growth of young trees, the disappearance by natural agencies of old trees similarly unreplaced, excessive lopping, bad treatment generally, have denuded very large areas of the Bhinga forest of all useful forms of timber. Much of the ground was covered over with a dense and exclusive growth of thorns. Elsewhere, a thick matted turf, that sure accompaniment of heavy grazing in open glades, opposes its impenetrable surface to every kind of seed. Everywhere the ground is of an adamantine hardness.

There are no signs of a vegetable soil. Where not clothed with turf, the naked understratum of heavy loam, often a pure clay, stands out yellow and staring. What has become of the *original rich light soil to which those tall fine old sál trees, still* many in number, are living witnesses? It has passed away generations since along with those conditions which, in great part, contributed to its presence. The ancient medium in which these patriarchs first took root has vanished in the process of time, and in the absence of those arrangements which, at a former period, nature had made for its maintenance and renewal. Its diminishing riches have been robbed by successive exposure to the sun's heat, stamped out by the heavy tread of generations of cattle, destroyed by fires, washed away by the waters, scattered abroad by the winds of heaven. During the dry months of the year, no dews form on this nude surface, from which all herbage is cropped close to the ground. Everything is then

dry, parched, and barren. At that period, we find ourselves mechanically calculating the depth to which the roots of the trees must be imbedded that the latter should be there and yet live. We find no difficulty in realizing the various steps which will finally usher this cattle-ruined forest into that condition of barren waste which will deny to man even a sustenance for his flocks. Much of the forest has already reached this stage. During the monsoons the waters, not being readily absorbed by this dense compressed soil, accumulates on the surface, inundating the ground at periodical intervals—often to the depth of a foot—and causing much seed, notably sál seed, to perish. Such plants as are able to withstand so many inclement conditions are mostly species showing a preference for heavy, clayey soils, in the monsoon slush of which their india-rubber-like seeds would appear to find a congenial emollient. Ebony (*Diospyros Melanoxylon*) belongs to this class. But well as ebony reproduces itself under the above conditions, circumstances are too hard even for so hardy a species, and it grows up, slowly and painfully, into a short and stunted tree. Thorns alone would appear to be here in their element. The whole forest is invaded by thorns, and in time it looks as if there would be nothing else left.

Let us now turn to a study of the differences between this grazed portion of the forest and the small areas that have, for a period of ten years, been protected from cattle. It should be mentioned that the whole forest has been preserved from fires, the grazed area, in fact, containing nothing that would readily encourage a conflagration. Evidently, the condition of these closed tracts must, at one time, have been very similar to what we have seen to be the case outside, since they were not selected for their much superior appearance, but for their situation, which permitted of their being closed with the least inconvenience to the people. It is true that we find but few young sál on the ground, and that these are weak and sickly. But what about that? Nature does not work miracles. For her to do so would be to give encouragement to the abuse of her laws. What are ten years to her? Shall she hasten because we have been so foolish as to deal with the work of ages as we would deal with a cabbage garden? Think of what this soil was before we commenced to exclude cattle from it! It is impossible that sál can yet thrive in such a soil as this, at least not without the aid of expensive proceedings on our part to further its reproduction, and to relieve the severity of its early struggles with so many adverse conditions. What we do find is a very apparent amendment in the soil. It is no longer so hard. Waters do not accumulate on the surface during the rainy season. A thick undergrowth of leafy shrubs is contributing much to the richness of the soil in certain localities, and this cover is gradually extending over the whole area. The reproduction of ebony is very

good, and the poles of this species are straight and vigorous-looking. Every where, such parts of the forest as are insufficiently sheltered are grown over with a dense covering of grass, from 2 to 3 feet high; and this grass is saturated with moisture during the whole of the winter months, forming in this respect a striking contrast with similar open tracts in the forest grazed over. There is no turf to be seen any where, and conditions for reproduction are excellent for such species as can conform to a soil still very heavy and of indifferent quality.

I have dwelt at considerable length on the subject of this Bhinga forest for two reasons. In the first place, I wished to show the unreasonableness of expecting the immediate reproduction of superior species in soils no longer suitable to them in this respect, and secondly, I desired to give an impressive instance of the ruin which must, under certain conditions, overtake sooner *or later every forest burdened with the unnatural* plague of cattle-grazing, even when the cattle do not themselves feed on the species constituting the forest. That grass against which so many of us rail, and not without cause, has its useful purpose. Its absence in over-felled or poor forests is the one great cause of soil deterioration, and, of course, this is synonymous with forest deterioration. The grass is here but the protecting cover given by a thoughtful nature wherewith to shield the soil from the rays of the sun and the action of the elements. It serves to prevent evaporation. It invites the formation of dews, by the aid of which the young plants are enabled to bear up against the subsequent drought of the three hot months preceding the rains. Once reproduction has taken place, the shelter of the grass is keenly relished by the sál seedling, a fact patent to any body who will take the trouble of observing seedlings of this species placed in the two opposite conditions represented by a grazed forest and a forest not subject to the action of cattle. In the former case, the seedlings that have escaped being trampled upon will be found to suffer bitterly from frosts, and then to die off in great part from drought. *In the grass we shall always find the young* sál seedling looking green and vigorous. I have seen them so in grass 4 feet high.

To admit, therefore, even a moderate number of cattle into forests suffering from an ill-conditioned soil, such as the closed tracts in Bhinga, would be a *most suicidal* thing to do, seeing that the soil is there in process of recovery from the curse of this same cattle-trampling—*always a fatal thing in clayey soils*— and of having its impoverished surface denuded by the same agency. It is necessary, therefore, to always ascertain whether the failure of reproduction has not been due to some other cause than the mere prevalence of a dense crop of grass on the ground.

On the other hand, it is, as already mentioned by me, most

true that the accumulation of grass and leaves in sál forests not subject to grazing or fires is often a serious hindrance to the reproduction of that species, if not to other species similarly situated. I passed the whole of the rainy season of 1885 in the Bhinga sál forest, as also a portion of the preceding monsoons, with the principal object of studying sál reproduction, and the circumstances which influence it.

The result of my observations was that sál seed in the closed tracts did not, over very large areas, come into contact with the soil at all. Opposed in this by its large wings, which helped to keep it suspended in the decaying grass, the sál seed was still further impeded by the solid shield presented by the last fall of leaves from the neighbouring sál trees—leaves still tough and leathery and pinned into position by the standing grass—the whole constituting a barrier beyond which hardly a single seed could penetrate to the soil below. Suspended in this dry medium was an immense quantity of sál seed which, after sending out their tender radicles in an exaggerated and vain attempt to reach the soil, finally all withered up and died. *Immediate contact with the soil appeared to be a "sine quâ non" condition for successful reproduction.* The intervention of even a rich mould of decomposed vegetation was not conducive to good results. In this latter case, as outside the closed tracts generally, the seed rotted from excessive moisture. *Given the necessary and indispensable condition of a soil not subject to inundation, or to an excess of moisture, the sál seed only germinated and took root profusely where nothing opposed its falling in immediate contact with the naked surface of the soil, and so long, always as its tender radicle effected its entrance into the ground without having been unduly exposed to the action of the sun and atmosphere.*

In such parts of the closed tracts as were moderately well covered by the aid of leafy undergrowths, and in which the grass was consequently much less thick, I observed plenty of reproduction of sál. But the most abundant crop of seedlings was to be seen on a tract of 30 acres that had been burnt during the previous hot weather. There were not many sál trees growing on this tract, but for 40 yards—*it is as well to observe that sál seed in no instance spread in this forest further than 40 yards from the parent tree*—around every such tree the ground was *covered* with sál seedlings.

Outside the closed tracts, much of the ground was inundated, so that the seed there rotted. Much seed again perished by exposure to the sun, and a large quantity was trampled upon by cows and buffaloes. The sál seed is as tender a thing as a green pea, and the least touch will break the radicle, which shoots forth to the length of an inch very soon after the seed has fallen from the tree. I, in no instance, however, observed the seed to fall with the radicle already showing. For the same reasons, a very short exposure to the sun's says is fatal to the seed. Un-

doubtedly, under conditions similar to those obtaining in the closed portions of the Bhinga forest, where the stock on the ground is comparatively valueless, I should unhesitatingly recommend, as being the best plan to secure the needful reproduction of sál, and provided always that the quality of the soil admitted the hope of this reproduction leading to good results, *that the whole surface be burnt over on the advent of an abundant seed year*. Under conditions precluding such an extreme measure as this, I would suggest that the grass be beaten down, and the surface soil excoriated by means of a heavy beam,* 6 or 10 feet in length, with transverse convex grooves to it, and drawn by bullocks in imitation of the common harrow, or roller, every where used by cultivators in this country. The work could then be directed over such tracts as alone required this remedy. I have often observed in sál forests, where the soil was of good quality, what a number of seedlings was to be seen in the tracks of carts that had passed through patches of forest in which a dense growth of grass had hitherto obstructed all attempts at reproduction.

As I have already said at the commencement of this article, I see no objection, under such circumstances as the above, to "light" grazing, assuming that it is possible to confine the number of cattle within limits, and that the remedy would not be constituted into a continuous one. In the latter case, the benefits contributed by cattle in one part of the forest would be outbalanced by the number of seedlings killed, or mutilated in another, while the evils of surface hardening, and the certain risks of fire, consequent on allowing the public into the forest, would be always present.

Speaking of the Bahraich district only, I am positive that I should not be able to confine the number of cattle within the limits defined by a subdued form of grazing, such as would be required for any special purpose of thinning out the grass.

It is evident to me that a concession of the kind demanded by the advocates of "light" grazing, if applied to the now closed portions of the Baharich Government forests, would have the following consequences:—

1. There would be a new incentive to breeding cattle on the part of the cultivators living off the forests, and whose principal grazing grounds the latter are. The present grazing dues are *nominal* in amount, and the facilities for evading payment altogether are numerous, and generally taken advantage of. The tending of cattle itself is, therefore, not only a very profitable occupation, but a task more congenial to the people than the drudgery attendant upon agricultural pursuits. Already a number of cattle are maintained by the population, to a considerable distance from the forests, that is greatly in excess of what even self-interest would, under ordinary circumstances,

* *Vide* review on Bengal Report, in this number.—[ED.]

dictate. This is due to the facility already recorded by me with which the payment of the tax is evaded, also to religious feeling which opposes itself to those means of confining cattle within bounds that are available to other nations. In this way, our forests provide for a large percentage of old, maimed, diseased, barren, and otherwise unprofitable cattle. The Bhinga forest has thus become the home of several thousands of ownerless animals, from which herds of semi-wild cattle have, in process of time, been formed, and which now do much damage to the crops of their former masters, giving rise to complaints about the losses inflicted by the near proximity of the forest.

I only mention these facts to show the difficulty even now of keeping the cattle of the villagers within *reasonable* bounds. Shall we be able to do so any better when we have opened a still larger field for cattle grazing? Does not every circumstance point to the certainty of these same cattle increasing to an *extent which can only end by our being obliged to open permanently* that which, at first, it was only intended to open temporarily? It is all nonsense to expect political foresight, and a regard for mutual interests, on the part of people who breed great bulls only to send them to devastate the crops of the community at large. Where 10 square miles of forest have been left open by us for pasture, every owner of cattle for 20 miles round—and every man is such an owner—considers every acre of this open forest as being his own particular and private property.

He ignores the existence of all other cattle, and, if he had only the money to effect his purpose, he would place as many cattle of his own on the ground as there are stones on its surface. If his cattle come to die, under these conditions, he will clamour until more forest is opened out to him, and so on until the whole area is grazed over; first lightly, then excessively, then so much so that the cattle die off wholesale in a famine. But not before the last granary for the supply of requirements that are fully as much needed as *ghee*—neglecting such factors as climatic considerations—has been ruined past redemption, *even as a grazing ground. And by such gradual processes is the* goose exterminated that lays the golden eggs, political economy being made to give place to the political expediency of the hour. And, after all has been said, who are to be the real gainers? In Bahraich the real gainers by the privileges in our forests are some two or three very rich "talukdars," who own all the land lying off the forests, and whose tenants, being mere tenants at the will of the landlord, have to pay *per le nez* as they say in French, for every extension of the privileges granted by us. Surely these people must laugh in their sleeves at all the good things that we propose doing for them.

2. An increasing number of people of purely grazing castes would come and settle on the outskirts of our forests instead of

proceeding, as most of them do now, to the more distant, but natural pastures of the Nepal Terai.

3. Attracted by the same accumulation of fodder in tracts to be opened to the public after careful protection, people would bring their cattle to our forests from much greater distances than had been hitherto customary.

The result of this general increase in the number of cattle to be provided for would be two-fold. In the first place, the tract hitherto reserved, but now opened for a time to the people, would be burdened with the presence of every head of cattle from far and from near, the owners all equally anxious to make the most of the limited time allowed them. All those cattle which formerly distributed themselves more or less evenly over an extensive area of forest, and now increased by a large percentage of new arrivals, would be packed into the perhaps relatively confined extent of the reserved tract. The result would evidently be more or less disastrous according to the size of the tract thus temporarily opened to the public. It is difficult to believe, however, that in any case the term of "light" grazing could be honestly applied to the proceedings. But, of course, I can only speak here of such forests as I have become acquainted with during the term of my service.

The other result I have already referred to.

The people, with their increasing herds, would soon clamour for the permanent opening of such tracts as we, for a special purpose, in an evil hour agreed to open as a temporary measure only. Once a privilege has been conceded, it is easy to extend it, but very difficult indeed to abolish it, or even restrict it.

CAMP, VIA BAHRAICH :
8th February, 1886.

E. P. DANSEY.

Note.—Since writing this article I have more carefully read the correspondence that exists on the proposed introduction of a system of "light" grazing into some of our forests. Among other things, I notice that conditions are generally very different in Berar to what they are in Oudh. For instance, Mr. Drysdale talks of the useful agency of cattle as seen in the way which the seed are pressed by their heavy hoofs into the soil. Evidently then, he cannot at all refer to sâl seed, the lightest pressure on which would be similar, in its effects, to the same pressure on a boiled potatoe. And again, Mr. Drysdale has nothing to fear from fires, seeing that he only opens his forests during the monsoon months. In Bahraich, the people would not thank me even if I permitted them to graze at that season of the year. It is during the dry months of the year alone that the populations of Bahraich would like for permission to enter the closed tracts, and then the danger of fires is itself sufficient to make us hesitate before acceding to even the prospect of "light" grazing. Practically again, in Bahraich, we should never be able to confine cattle within ***given numerical limits.*** Their number is legion, and the difficulties in the way of enumeration and control enormous. All we could do would be to restrict the grazing to a short period of the year, and in my article I have dwelt on the fallacy of even this attempt at "light" grazing.

LIGHT GRAZING IN RESERVES.

YOUR magazine for January last reached me but a few days ago. It contains two papers sent you by correspondents, "Tops" and "W. E. D'A." on light grazing in reserves, and your review of the Berar Forest Administration Report for 1884-85. As I have succeeded Mr. Drysdale in Berar, and as all the three papers are chiefly written with reference to the light grazing system now adopted in Berar, I wish to offer a few remarks on them.

"Tops" in his paper makes use of expressions, and, as it seems to me, writes in a style which do no good, and are not arguments for either side. Thus he writes, "that reproduction can be improved by continual light grazing is false, and is, moreover, not proved by Mr. Drysdale" * * The fact that continuous grazing of cattle is prejudicial to reproduction cannot be upset by a few casual observations and rashly drawn conclusions." Elsewhere, "Tops" writes of "accurate observation" showing this thing; that that thing will be agreed to by "any accurate observer;" and that something else is known "to every observing forest officer." These be "prave 'orts," but they are nothing more. The first thing is, perhaps, to state exactly what is being done. In Berar light grazing in the reserved forests means that a limited number of cattle is allowed to enter the forests from after the fall of the rains to the end of October. There is thus no "continual light grazing," far less as "Tops," who *vires acquirit eundo*, finishes with "continuous grazing."

"Tops" announces the following dictum, "whether any real advantage exists in their exposure is more than problematical." The exposure, that is, to light and air of seedlings crowded up in high grass. I read that, in the tree-forcing climate of Burma the teak sown in toungya lands has to be kept clear of weeds and grass. Several of Dr. Brandis's old notes and suggestions for various provinces advise the sowing of seeds in lines, and *keeping the lines clear* of grass. In the advanced forestry of Europe, the art of the forester is shown by the removal at the proper time of trees to promote the growth of seedlings underneath them. It, then, seems reasonable to suppose that young tree growth in long dense grass is hampered and often stifled by the grass over it.

"Tops" tells us to consider "what takes place in a forest of the usual open character of most of our Indian forests when strictly closed by fire protection," and says, "numerous seedlings have in the meantime sprung up in the standing grass which at this period begin to show above the dead grass." I am acquainted with the forests of Mysore, of the lower forests of the School Circle, with many rakhs and deciduous forests of the Punjab, besides the hill forests, and have now carefully in-

spected many of the dry forests of Berar. I am not acquainted with "most of our Indian forests," as doubtless "Tops" is, so I can only offer the results of observation, made with great care and set down accurately, over a limited but not very small area. I have found that seedling growth in dense grass grown plots, bare of roots or stumps, is, even when seed bearers are not far off, *exceedingly rare*. Further, that young coppice growth, even, is much retarded, and often killed, by the dense growth of grass. In 1881-82, I inspected in company with Mr. Lowrie, then in charge of the Saharanpur Forest Division, a large extent of land covered with dense growth of grass in the fire protected reserves below the Siwaliks. Mr. Lowrie will remember how carefully we examined the ground, and found no reproduction, either seedling or coppice, except where the soil had been well turned up by wild pigs, so numerous thereabouts. I sent a note on the subject to Dr. Schlich, then acting for Dr. Brandis, and he, replying, did not traverse my conclusions, but thought it better not to do anything just then.

The paper by "W. E. D'A." is worth consideration, though I do not agree with his temperately expressed conclusions. As cattle are not admitted into the Berar forests till after the rains have commenced, and are turned out long before the grass is dry, we have no need to fear fire caused by the cattle owners. Nor do I see why the Forest Department should attempt, indirectly, to force the ryots of India to keep a smaller number of cattle, by limiting grazing. Supposing that a year of drought kills off some thousands of cattle, such years, after all, are exceptional, and a whole generation of cattle may grow up, work and yield milk and manure to the great advantage of all concerned, without having to undergo a year of famine. Then, in Berar, as also in other parts of India, there are still large numbers of pack cattle employed in the carrying trade of the country, and these require to be supported at slack times. If then the forests can be made use of without damage to themselves, to supply a certain quantum of grazing, they should be so used. It is better to let the grass be removed by grazing than to let it accumulate for years, as much of it will then be useless as food fodder.

My experience is that, a dense growth of grass prevents all seedling reproduction, that, provided there are living roots and stumps in the ground, coppice growth will reproduce itself, but all the quicker in proportion as the grass is thinned out. That, as a rule, the tree reproduction found in such places is coppice growth, and that it is not till this coppice has prevailed somewhat, and so cleared the ground, that seeds can find their way to the soil and there germinate and take root. I have not found that cattle (*bidentibus exceptis*, as old White of Selborne says) do this growth any perceptible harm if allowed to graze within certain limits of time and place. On the contrary, I

believe that, carefully regulated, such grazing does good, and that if seed is scattered freely over the ground where such cattle are grazing, they, by the action of their feet, and the pressure of their bodies, open up the soil and press the seed into it. That, except where it is, on other grounds, necessary to plant up the land regularly, such action will be cheaper, more certain and more expeditious than any other practicable means in reproducing tree growth on areas almost bare of, but possessing soil fit to carry, trees.

Where the grass has regularly got hold of the land to the exclusion of all reproduction, and I have found such places in more than one forest, it will be well to burn off the grass, and sow the ground thickly with seed.

"W. E. D'A." suggests that this privilege of grazing may in time be considered a right. The cattle owners pay a fixed fee for each grazing season calculated per head of cattle, and the Conservator has full power to stop grazing in a reserve at any time. The Government of India, too, in its 48F. of the 16th January, 1886, on the settlement of the Pilibhit forests in Oudh, has, in para. 9, laid down that "it cannot be admitted that a prescriptive right over any forest can be acquired by the continuous purchase of its produce from the owner at market rates, the element of adverse enjoyment and of enjoyment as of right on which prescription rests, being wholly wanting."

The question is, I think, how best to get rid of superabundant grass which affects tree reproduction. I prefer light grazing at certain seasons to the use of the sickle, which takes off grass and young tree growth impartially. I do not pretend that light grazing is good at all times and seasons in all forests, but only that it is proper in the present condition of many of the Berar forests, and certainly was so, in 1881-82, in parts of the Siwaliks, if not now for aught I know. It is being tested now, for the first time I believe in India, and so far appears to be good. Time will teach us all more.

These remarks have run to so great a length that I shall not trouble you with more on this point on your own review of the Berar report for 1884-85. But I cannot allow that review to pass quite unnoticed.

You say that much is made of cutting back badly grown teak over a small area. My remarks on it are confined to some six lines of print. But the point is that it has been carried on for years, that Mr. Ballantine was the officer who began it in 1868; and I remember that when the officer then in charge of the Punassa forest in the Central Provinces, some years back, carried out the same work to a small extent, it being introduced into Punassa from Berar, it was written of at great length, and very favourably noticed by the Inspector General of Forests. This careful felling of trees with a view to insuring good reproduction on fresh roots is a most important matter, and I do

not think that we can insist upon it too strongly. It is a work requiring care and much supervision, has nothing wonderful about it, but produces great effects on the future value of a forest.

Next you seem to think that fire conservancy in Berar is specially easy ; and then you go all astray as regards facts. Writing of the Melghat you say "The fact is * * * that the Melghat forest of several hundred square miles in a compact block with the divisional officer's house in its centre, is easier to protect than the scattered blocks where fire conservancy is often attempted." Now, "the fact is" that the Melghat forests are in three blocks, two large and one small. The large blocks have for some years been separated from each other by some miles of open forest, and the divisional officer's house is at Ellichpur, 20 miles distant from the nearest block. Then, away from the Melghat forests altogether is a trifle of 2,67,756 acres of succesfully fire protected forest in Berar, separated into 12 forests contained in 21 separated portions. The success is due to the good work done by Forest officers, and to the help given by the Civil officers, and to the generally good feeling among the rural population.

G. J. van Someren, *Lt.-Col.*,
Conservator of Forests, Berar.

LIGHT GRAZING IN FORESTS UNDER REPRODUCTION.

The remarks in the January Number of the "Indian Forester" on the subject of light grazing in forests under reproduction, have reminded me of a duty which I consider all foresters who have thought on the subject owe to the forests in their charge.

When reading the letter of the Government of India circulating Mr. Drysdale's report and recommendation, I was, to say the least, surprised ; the recommendations being directly contrary to what we are taught, and to my experience of several years in the forests, and my attention has been more especially drawn to the subject of grazing, as this has been the cause of much difficulty in the management of the forests under my charge for several years past. One point more particularly surprised me, and that was that Government should accept the success of the experiment as having been established by one season's trial.

Mr. Drysdale, it is observed, speaks of *light* grazing, and tells us that this allows three acres per head of cattle, of cows and bullocks, and that this grazing is limited to the rainy season, July to October.

The extracts from the inspection reports given in the Circular

are interesting, and I am induced to reproduce them below. Mr. Drysdale says :—

"I was agreeably surprised to notice the small effect light grazing had had on the crop of grass. In most places an inexperienced person would hardly have observed that grazing had taken place at all.

"The grass appears to have grown almost as quickly as it was eaten, and there is still a sufficient supply to meet all possible requirements.

"It was also a matter of satisfaction to me to notice that natural reproduction was much more plentiful in places that had been lightly grazed than in completely protected localities. This may be accounted for in a great measure by cattle treading seed into the ground, and also by fewer seedlings smothered by a rank growth of grass.

"The same result is observable in places where broadcast sowings of teak seed have been made."

The Conservator's remarks in the body of his Annual Report for 1883-84—"It has been definitely proved that, with successful fire conservancy reproduction may be looked upon as a certainty"—accord with the result of the experience gained in other parts of India, and do not lead one to expect a recommendation for opening these same forests to grazing even of the limited nature in question.

The number of seedlings found on the areas grazed and not observed on those protected from cattle can, it seems to me, be accounted for by the fact of this grazing having exposed them to view. I could mention a case of this nature in this division. Many of your readers have probably observed the number of seedlings that catch the eye of a person walking along a forest path growing on the bank or on the path itself, from which the grass and other undergrowth has been removed ; when the same person turns off the path and walks at the same pace through the forest, how many seedlings does he observe ? Let him now, with the assistance of a couple of experienced forest guards, walk slowly over the same line through the forest, and, searching carefully, for every one that he observed before he will now find half a dozen or more.

It is assumed that the forests referred to are composed of various trees, of which teak is looked upon as the principal in point of individual value. Allowing the teak to escape the teeth and hoofs of the cattle, and to be benefited by having the thick grass cleared from above their leading shoots, there must be among the auxiliary species many seedlings that suffer, and these forming the bulk of the crop are more necessary to the well-being of the forest as a whole than the teak and other more valuable species, which probably form only a small percentage of the crop. Indeed the mere circumstance of there being a rank growth of grass is of itself evidence that the crop is not as complete as it should be, and can ill afford any of its component species.

If it is really the case that none of the seedlings suffer, whether of the principal or auxiliary species, the case is an exceptional one: the growth of grass is particularly luxuriant, and presumably from the proposal to exclude buffaloes, goats and sheep for fear they may browse the tree shoots, the cows and bullocks admitted are found to restrict themselves to the grass.

In cases where the growth of grass is very rank, and the seedlings are all of species not eaten by cattle, and at the same time of species that require much light for growth while young, it seems to me that it may be an advantage to utilize even grazing to thin out the grass, but of course introducing a sufficiently limited number of cattle to obviate the trampling down of the seedlings.

It would appear, however, especially regrettable that Government should act on a report on the experience of one season gained in one forest composed of certain species of trees, and should circulate this report to encourage officers in other countries, dealing with other conditions of climate and other kinds of forests and species of trees, to introduce a similar course of treatment. For instance, limited grazing in forests of pure sál would, in my opinion, be less harmful than in forests of oak and magnolias, but even if I were inclined to believe (which I am not) that grazing were beneficial to the reproduction of a sál forest, I trust no report of mine on the subject would be considered an argument in favor of grazing in the teak forests of the Central Provinces.

I am sorry to see that your correspondent "A. J. C." in your Number of last December omits to specify the forests he refers to, as it is difficult to believe that he recommends light grazing for all forests generally without reference to the kinds of trees composing them, or the system of working. Probably he refers to forests worked on the haphazard "selection" method necessitated by our system of permits sold to purchasers, in which the effect of grazing is not seen so soon as in recently worked areas in a forest treated on another method. Nor does he confine himself to recommending grazing, as Mr. Drysdale does, during the rainy season only. I do not wish to refer to more than one point of those which he mentions as grounds for his argument, *viz.*, that a fire in a forest protected from grazing does more harm than in another. This may be the case, but he will also probably admit that a forest in which grazing is allowed is more liable to be burnt than another.

I have read with interest the remarks of "Tops" in your January Number, and agree with him that the question whether the seedlings found so plentifully in the area opened to grazing were of the year or of previous years, and whether they continue to exist and thrive after several seasons of this grazing is important.

I would suggest that it would have been better if frequent observations had been made and recorded in the Forest Journals of the Divisions, and that no recommendation such as that of the Berar officers had been made until based on the experience of several years. On this point it will be noticed that the Conservator in August 1884, when forwarding his Annual Report for 1883-84, recommended that light grazing be allowed over one-half of the area of the forest, and in his letter of December of the same year, or four months later, only recommended that this grazing be extended over the whole area.

"W. E. D'A.," who also writes in your January Number, has very rightly, I think, pointed out the mistake in encouraging Indian cattle owners to unduly increase the numbers of their herds, and the permanent impediment this is to fire protection.

9th February, 1886. E. G. C.

SEMLA GUM IN DEHRA DUN.

Localities.—The Semla (*Bauhinia retusa*) is found all over the Sub-Himalayan and Siwalik forests of Dehra Dun. The principal localities where it is found abundantly, and where the extraction of gum is conducted on a large scale, being—

1. The Malkot pargana.
2. Parts of the Sherpur and Timli forests north of the Siwaliks.
3. The Tihri-Garhwal leased forests, especially the forest above Mansádevi between Chandnáwá and Barkot, and the steep slopes on the Ganges between Sheopuri and Tapoban. It is generally found in damp places ascending to about 5,000 feet. An average tree is 20 feet high and 3 feet in girth.

Season and process of collecting gum.—The trees are generally tapped once in every four or five years. If tapped oftener, the production of gum would be small, and the trees would be damaged seriously. There are two seasons for tapping the trees and the collection of the gum, and they are so selected as to avoid both the monsoon and the winter rains. For instance, some trees are tapped in September and October, and the gum is collected in November and December. Others are tapped in March and April, and the gum is collected in May and June. The tapping of the trees and the collection of gum are conducted by the same party of men, who go on tapping the trees from one end of a forest to another, and at the end of about a month come round and commence the collection of the gum from the same place where they had originally started the tapping. The work is generally undertaken by hill men from Jaunsár and Garhwal. The trees are tapped all over the trunk and the branches, including branchlets of 6 inches girth and over, when-

ever these latter are accessible. A light and sharp axe, about 2 inches broad, which the man carries in his waist when ascending a tree, is used for the purpose. With a single stroke he dexterously cuts through the bark and slightly into the sap wood (say $\frac{1}{8}$ of an inch). The wounds are generally cut as much as possible horizontally, and though they are not at regular intervals, their average distance apart is about 4 inches. Steps for ascending the trees are cut at every 3 feet in those with a clean hole, and they are very destructive to the trees, and should be prohibited, and a light ladder or a rope substituted. A brownish insipid gum exudes from the wounds, the outer part of which dries up gradually, forming a number of shining balls, which weigh about half a chittack each, and give a very singular look to the tree. The gum when fairly dry is collected and spread in the sun, and when thoroughly desiccated it is taken to the market.

Costs and profits.—The gum lessee employs hill men at contract rates for tapping the trees and collecting the gum. He purchases the gum, at places accessible to carts, at 14 dharis, or 70 seers, per rupee, all charges included. From the best data at present obtainable, it appears that one man can tap 40 to 50 trees in a day, or when collecting gum, can collect about 20 seers daily; also that an average Semla tree yields about 5 seers of gum. Though it is very difficult at present to estimate the number of trees leased in a certain year for a certain sum of money, and thereby to calculate the average royalty per tree, yet it may be said roughly that about 32 average trees are leased for one rupee, so that the contractor gets $\frac{32 \times 5}{40} = 4$ maunds of gum per rupee; or at a royalty of 4 annas per maund.

The gum is then carted to Dehra and thence to Saharanpur, where it is purchased in large quantities by merchants from Lucknow, Aligarh, Delhi and Amritsar. It is principally used, as far as I know, for sizing cloth, but it would be very interesting to obtain further details about the uses to which Semla gum is put. The average cost of transport from the forest to Saharanpur is estimated at Rs. 6 per cart load of 16 maunds, or about 6 annas per maund, and the price at Saharanpur is from Rs. 2-8 to Rs. 3-8 per maund, or an average of Rs. 3 per maund. Hence the profits may be calculated as follows:—

	Per maund. Rs.	A.	P.
Collecting gum and delivery to places accessible to carts, ...	0	10	0
Carting from forest to Saharanpur market,	0	6	0
Royalty, ...	0	4	0
Total cost, ...	1	4	0
Price at Saharanpur, ...	3	0	0
Profit, ...	1	12	0

No reliable data can be obtained at present as to the total quantity of gum exported in a year from the Dehra Dún forests, and this matter might be put up for future investigation with great advantage.

Treatment.—The Semla trees should be protected from fire as much as possible. They should not be tapped oftener than once in every four or five years, so as to allow sufficient time for the healing of the wounds. The cutting of steps in the boles for ascending the trees must also be discontinued to the great benefit of this useful species.

KARUNA NIDHAN MUKERJI.

PHOTOZINCOGRAPHIC PRESS FOR FOREST DRAWINGS, &c.

WOULD it not be a useful arrangement to start a small establishment for photozincographing and otherwise drawing maps, plans, &c., &c.? I would make it Imperial, and allow all Circles under the Government of India to have their work done there, and probably Dehra Dún would be the most central place at which to have it. At present we have either to rely on the kindness of the G. T. Survey Department, or worry the already very much overworked Forest Survey Branch (which, moreover, has not as yet any photozincographing press). As there are often maps, plans, drawings, &c., which do not need to be reproduced in large numbers, I would also keep a few draughtsmen, who besides would be necessary for colouring the plates that came from the photozincographing press. In this way Forest Divisional officers would be able to have several copies of their maps, which is often very desirable, since separate copies are wanted for fire protection, plantation work, and so on. Another consideration is that when some good idea for a bungalow, or whatever it might be, had been hit upon, the photozincographing press would enable us to publish it in the "Indian Forester," thereby saving a good deal of expense, and making it possible to reproduce, and reduce to portable sizes, maps, &c., that would be too elaborate for the Roorkee Press.

Finally, to turn to another subject of a cognate nature, would it not be a good plan to keep a qualified Native Surveyor in each Circle, whose work should consist entirely in keeping the maps up to date? In each division, a copy could be kept for these alterations and additions, which might be always entered by hand in red, so as to show that they had not been authoritatively passed as correct by the Superintendent of Forest Surveys, but which nevertheless Divisional officers could satisfy themselves were substantially right.

Q.

III. NOTES, QUERIES AND EXTRACTS.

ON RENDERING WOOD FOR BUILDING PURPOSES NON-INFLAMMABLE.*—The rendering of wood for house construction non-inflammable should be a subject of great interest to all. There is, however, little information obtainable from published works, though small hints on the subject may be sometimes met with in encyclopædias, &c. The preservation of wood from rot may be found treated of in several books, which contain also information on the physical construction of timbers, the various preservative solutions, and the methods of injection and impregnation. On all these points full information is necessary to enable us to take a comprehensive view of the matter.

Timber structures are often a necessary evil, either from fear of earthquakes or from scarcity of other material, either for the entire building or for the roofs only. I especially allude to Japan, China, South America, the Southern States of North America, and Jamaica, in which last the roofs are of shingles of willow—a very absorptive wood, and therefore one which might be easily treated with chemicals for resistance to fire. Let us see, then, how these wooden buildings may be preserved from destruction by fire in the best and cheapest manner, remembering always that though a single house so treated would not blaze, yet if in the midst of a large conflagration it would be carbonised, and thus destroyed, so that it would be necessary to have a block of prepared houses together in order to stem the tide of fire in a large timber-built town. This might be done by Government order, by arrangement between the house-owners, or with a fire insurance company. The reduction in insurance rates alone would pay a handsome interest on the first outlay.

Let us, then, pass the various processes in review, with their advantages and disadvantages fully set out, and with their capabilities for preserving textile fabrics, as well as timber, from fire.

Should it be decided to impregnate the wood with chemicals, this can be done, or a superficial coating over the wood may be applied of fireproof and waterproof paint, or both, though many prefer the internal woodwork plain. Any preservative used in

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* A paper by Mr. Thomas M. Rymer-Jones, Memb. Inst. C.E., F.R.G.S., and Mr. John Rymer-Jones, Memb. Inst. Tel. E. Read before the Civil and Mechanical Engineers' Society on the 22nd ultimo.

external situations should not be liable to be washed out by the rain. How far those non-inflammable salts which unite chemically with the nitrogenous matter in the wood are capable of resisting wet it is difficult to say with certainty, but there are some which we shall proceed to give further on, which do effectually resist both water and soap.

Again, it must be a *sine quâ non* that, whatever the fireproofing material may be, it must be one which, when exposed to the action of fire, does not give off injurious or suffocating smoke.

Also, if the impregnation of the timber is to be thorough—*i.e.*, through the whole of the wood—it would be most advantageously done while the wood is green and the sap uncongealed; otherwise the tubes become clogged, and the injection of the chemicals extends only to a certain depth in the wood if the latter is dry.

Impregnating the timber when green, and operating on large balks, would perhaps be more economical than upon smaller pieces when cut up; but the salts are said to cause shortness of grain, so that it might be difficult, with the ordinary hand-saw, to cut out the finer kinds of woodwork used for interiors.

Lastly, if the woodwork is impregnated when green, the solution acts chemically on the sap, and destroys the germs of rot. Of course the "shortness" of the wood, caused by salts applies to balks, whether prepared when green or well seasoned.

With regard to the construction of the tree itself, Dr. Boucherie considers that no connection exists laterally between the vertical sap-bearing tubes, as is shown by applying a coloured solution, under a moderate pressure to certain tubes at one end of a felled tree, when the same tubes at the other end of the tree, and only those, become coloured, and a pattern, such as the name FARADAY, so injected was found perfect at any point of the tree where a cross-section was made. Langdon, however, points out that "in timber creosoted under pressure the creosote penetrates between one or two inches," showing that there is some lateral connection, although so slight that if required to be done thoroughly the injection should take place from the ends.

Although the solutions used generally for the preservation of timber from rot need not be the ones best suited for rendering the same fireproof, yet the methods of application are similar.

The soft woods, such as Scotch pine and spruce, are usually best suited for treatment, their grain being coarse and the annular rings far apart, tissue soft and capable of great absorption, rendering them, when prepared, more lasting than closer-grained woods, owing to the density of fibre not permitting the latter to be thoroughly impregnated. We are thus enabled to use the cheap quickly-grown woods, the processes for rendering them non-inflammable at once preserving them from rot and from the attacks of insects and worms.

The idea in the ordinary methods adopted for preserving timber from rot is to introduce into the pores of the wood some salt, which, uniting chemically with the albumen of the sap, shall convert it into an insoluble compound. The best known of these methods are Burnettising, Kyanising, and Boucherising.

Burnettising consists in impregnating the timber with a solution of chloride of zinc of the strength of one of the salt to thirty parts of water. *Kyanising* consists of impregnating with chloride of mercury (corrosive sublimate). The treatment by both these processes consists in immersion in open tanks, or more thoroughly by pressure of 110 to 150 lbs. to an inch in closed wrought-iron cylinders; but it is questionable whether these methods are so good as Boucherising, as by them it is necessary to force the solution into the wood at right angles to its tubes, thereby injuring its strength, and letting the sap, which is the immediate cause of decay, remain, the coagulation of the albumen at any material depth below the surface being a matter of doubt, whilst the cost to obtain even that amount of saturation would, *cæteris paribus*, point to the *Boucherising* method of injection as most suitable to our purpose. For this newly cut, green timber (coarse-grained is most suitable), before the bark is removed, is exposed at the end (either end will do) to a slight pressure from a liquid column of sulphate of copper (1 lb. of sulphate to 5 gallons of water or 1 to 100 by weight, allowing 0·35 of a lb. of sulphate to 1 cubic foot of timber), arranged in a tank 25 to 50 feet above the level of the log. The liquid drives the sap before it and forms chemical combinations which preserve the wood from decay. The sooner this is done after felling the better, as the resinous substances rapidly harden and prevent the movement of the liquid salt through the pores. The plant required is small and easily erected close to where the wood is cut, and can be quickly shifted to a fresh situation. The time for the appearance of the liquid at the top of the log is from 2 to 24 hours, when it drops into gutters placed to catch it, and is pumped up into the cistern to be used again. About three days are required for a 25 feet log, and the process is complete when every portion of the top of the log is found to be saturated. This is known to be completed when a brown stain is left on the timber by the application of a piece of pottassium ferro-cyanide. The cost of the process with sulphate of copper is about $2\frac{1}{2}d.$ per cubic foot for logs 25 feet long. It has sometimes happened that the heartwood, which is more durable under ordinary circumstances, has in Boucherised timbers rotted, leaving the impregnated sapwood sound. Care should be taken to obtain the sulphate of copper as free as possible from iron, but as it is usually present in some degree it is as well to make a saturated solution and allow it to remain exposed to the atmosphere as long as possible, so as to allow the iron to deposit

at the bottom of the vessel, after which it may be diluted. If the solution is too strong, it is liable to contract the sap vessels and to crystallize at their ends. The water must be free from lime and perfectly clear. If it contain lime it is as well to add a little sulphuric acid to precipitate it, and either allow it to settle or filter the water through sand, for even the slightest cloudiness interferes with the injection.

All timber, when treated by any of the preservative processes in general use, becomes short, that is, it breaks in two crosswise easily, and when impregnated its tensile strength becomes impaired. It loses when dry a portion of its elasticity, but regains much of this when in a moist state. The shortness is easily tested, as, on trying to split with an axe a piece of dry preserved timber, it will be found that the axe will not follow the grain of the wood ; this seems a reason in favour of impregnating the wood, and especially the smaller pieces, after they have been cut and fitted into their several positions.

No ungalvanized iron should come in contact with wood impregnated with sulphate of copper (and the same point must be considered when using other salts), otherwise the copper of the solution will be reduced by galvanic action.

The sulphur itself is injurious, not only attacking the galvanizing of telegraph stay wires, but eating away the iron itself, showing that when salts are used for impregnating wood some protection, such as paint say, must be used to preserve the iron fixings. Kyanising (chloride of mercury) is equally injurious. Another process of preserving wood from decay is by using borax to neutralize the decaying vegetable matter in the wood. This is also a very good non-inflammable solution.

We have entered thus fully into the methods of preparing wood with chloride of zinc, chloride of mercury, and sulphate of copper in particular, because, whatever may be the non-inflammable solution selected as most suitable, some such method of injection will be necessary if the impregnation is required to be other than merely superficial. All these three being salts will not only preserve the wood from rot, weather, insects, and worms, but will to a certain degree render it non-inflammable, but which solution is best we shall be better able to judge later on. We may at once put chloride of mercury out of the question, as it is very expensive, and, when burned, is turned into vapour which is fearfully suffocating.

Sulphate of copper is cheap and free from this objection, but turns the wood a bluish colour when the surface is exposed to a damp air. Chloride of zinc and borax, the other two abovementioned processes, preserve from decay and flame, and might be used for injecting green timber. But at present let us go through the information that can be gathered on the subject of non-inflammable compounds and solutions. Much of this relates to rendering fabrics non-inflammable, and this is done by

steeping them in almost any saline solution. Thus cotton and linen fabrics prepared with a solution of borax, phosphate of soda, phosphate of ammonia, alum, or sal-ammoniac do not suffer active combustion nor burst into flame. The salts act by forming a crust of incombustible matter on the surface of the fibres. They do not, however, prevent the carbonisation of the material at a sufficiently high temperature. For ladies' dresses 1 oz. of alum or sal-ammoniac to the last water used to rinse them is sufficient for safety from fire ; a less quantity added to the starch would suffice. None of the above are used for fine muslins, as they render the fabric harsh and destroy its beauty. Sulphate or phosphate of ammonia are efficacious, but interfere with the ironing. The salt which answers all conditions is tungstate of soda. Steeped in a solution of 20 per cent. of this salt, muslin is perfectly non-inflammable when dry, and the saline film left on the surface is of a smooth and fatty appearance like talc, easily ironed, and adding a richness to the appearance of the material. The addition of a little phosphoric acid or phosphate of soda to the tungstate is recommended, as without this the tungstate is liable to undergo a chemical change and become comparatively insoluble. For a solution of tungstate of soda of minimum strength dilute a concentrated solution of neutral tungstate of soda to specific gravity 1·14, and then add 3 per cent. of phosphate of soda. This solution is found to keep and answer its purpose well.

Tomlinson says that out of 40 salts tried, four only were applicable to light fabrics, *viz.*, phosphate of ammonia, chloride of ammonium (sal-ammoniac), sulphate of ammonia, and tungstate of soda. The sulphate of ammonia is the cheapest salt, but causes brown spots on the muslin when ironed, and dissolves in water, so that it has to be renewed after every washing ; tungstate of soda is therefore usually adopted.

The oxides of tin withstand both water and soap, but render fabrics yellow ; consequently their use is restricted to canvas, sails, and other coarse materials : but this would not affect their use with wood. This is also the case with borate and phosphate of protoxide of tin and arseniate of tin. These last are some of the attempts which have been made to fix some of the non-soluble compounds in textile fabrics.

The method of rendering sail cloth permanently non-inflammable is to soak the convas for two days in a protochloride of tin solution of the strength of two parts of the salt to one of water, and to leave it for a day in a concentrated solution of stannate of soda or carbonate of soda. The canvas is dried, and is then ready for use. So much for fabrics.

Many of the objections to which the above solutions are liable would not affect their use for wood, and they may be well added to our list to help us to the selection of the most suitable one hereafter. The "English Cyclopædia" says : "Many methods

have been devised for making wood more or less fireproof. The substance which is most attracting notice now is silicate of soda."

Mr. Abel, Chemist to the War Department, England, and Mr. Hay, Chemist to the English Admiralty, made experiments with this salt in 1857 on a wooden hut painted three times inside and out with a solution of silicate of soda, but unfortunately for the fairness of the experiment the building (erected to try other experiments with) was constructed with a double boarding, so that it was only possible to coat or impregnate each plank on one side, but the value of the silicate was established beyond a doubt. A flame from a large heap of shavings played against the building for some minutes, but only succeeded in catching the end of one plank, and even that did not blaze, but only smouldered a short time. By the heat of the fire the salt was drawn to the surface of the wood, and formed a glaze upon it. Subsequently when the whole hut was destroyed by fire, although the fierceness of the flame was such that few materials could have withstood it, yet several planks remained of the exterior coated portion. Upon examining the planks the unprotected surfaces were found to be charred, but the charring only extended to those parts which had not been touched by the silicate. Asbestos paint has been used with nearly similar results.

So far as experiment has gone silicate of soda appears the most convenient and effective known for the purpose. Spon's Workshop Receipts says respecting silicate of soda: "Deal boards become almost incombustible when painted with a diluted solution of silicate of soda, called also glass water. The glass water is generally sold as a thick fluid like honey. This may be thinned out with water six or seven times its own bulk; the water must be soft, or boiled water will do, and apply the solution warm. In about 24 hours apply a second coat, and perhaps a third; use a new brush, and wash the brush clean after using, or it will become soft. Avoid grease or fat on the boards before painting them."

In the same book is another receipt as follows:—The timber to be soaked four or five days in a solution of 1 lb. of alum and 1 lb. sulphate of copper to 100 gallons of water in a tank sufficiently large to allow of the timber being kept immersed. The wood to be allowed to thoroughly dry before using. This would be a good plan to adopt with the large upright timbers after having injected them whilst green by the Boucherising process. Though owing to the blue tinge given by sulphate of copper that salt could hardly be suitable for interiors where the lighter woodwork was plain, yet chloride of zinc might be used for every part of the wood in a house, injecting it whilst the wood is green, as it acts chemically on the sap, and is white. Sir W. Burnett says: "Salt water only increases its efficacy. It is perfectly innocuous, and cannot endanger health. All the tim-

bers and ceilings of a ship may be impregnated with the solution without the slightest prejudicial effect on the crowded inmates. *It prevents the oxidization of metals, as has been* proved repeatedly on copper and iron bolts with the most satisfactory results, and articles prepared with this solution resist combustion in proportion to the strength of the solution."

By Maughan's process dry wood is saturated with an aqueous solution of phosphate of soda and muriate or sulphate of ammonia ; a decomposition ensues, followed by an evolution of ammoniacal vapour *and the formation of an incombustible coating* on the surface of the wood.

Jackson's patent consists in the application of salts of zinc and ammonia.

Mr. Payne's process of rendering wood fireproof is by pressing a solution of sulphuret of calcium or barium into the wood in a confined tank, and allowing it to remain at a pressure of 110 to 140 lbs. per square inch for an hour, then drawing off the solution and treating the wood in a similar manner with an acid or a solution of some substance such as sulphate of iron, which will unite with the barium or calcium, and set the sulphur free. When the wood is to be impregnated with a large amount of solid matter it should be dried between the application of the two fluids. By this means an insoluble sulphate of lime or sulphate of barium is formed in the body of the wood, which is thus rendered nearly as hard as stone. Wood so prepared is now largely employed on English public works and railways. The most porous, the softest, and of course the cheapest, woods are rendered equal in point of usefulness, durability, and strength to the hardest and best description of timber, and are susceptible of a high polish.

Professor Fuchs invented a solution of 10 parts of potash or soda, 15 parts of fine silicious earth, with one part of charcoal, mixed with water. This composition applied to the surface of the wood forms a vitreous coat which effectually resists the action of fire. Decisive experiments have fully established the efficacy of this plan, and the Royal Theatre of Munich was protected by the application of it. The surface covered was upwards of 400,000 square feet, at an expense of £200, or 100 square feet for one shilling.

A somewhat similar English composition consists of one part by measure of fine sand, two parts of wood ashes, and three parts of slaked lime ground together with oil, and laid on with a painter's brush, the first coat thin and the second thick. This forms a strong adhesive compound, both fire and waterproof.

Saloman's patent consists in an application of two solutions to the surface of the wood, the first consisting of sulphate of alumina, glue and water, the second of chloride of caldium, glue and water.

In Spon's Workshop Receipts a wash composed of lime, salt,

and fine sand, or wood ashes, is recommended to be put on in the ordinary way of whitewash ; it renders a shingle roof fifty-fold more safe from fire from falling cinders in case of fire in the vicinity. It has also a preserving effect against the weather, and the older and more weather-beaten the shingles the more benefit derived. Such shingles are generally more or less warped and cracked, and the application of the wash to the upper surface restores them to their original form, thereby closing the space between the shingles, whilst the lime and sand, by filling up the cracks, prevent them from warping.

By the addition of a little lamp-black the wash may be made of the same colour as the old shingles, and thus remove the offensive glare of a whitewashed roof.

Such is the information we are able to glean so far ; and, before offering any suggestion of our own, let us remember that to season timber in the ordinary way requires seldom less than three years, often six or eight years' exposure to the air freely ; whereas by the Kyanising (chloride of mercury) process, rendered unfit for our purpose by the suffocating fumes thrown off on exposure to great heat, Burnettising (chloride of zinc), Boucherising (sulphate of copper), and Beerising (borax) systems, the destructive principle (sap) is dried, and rendered inert, thus making larch, firs of all kinds, willow, birch, elm, beech, ash, poplar, &c., of considerable value for durable purposes.

We would suggest the following, giving preference to the solutions recommended in the order named :—

For houses already built, apply several washings of silicate of soda, sulphate of copper, or borax, to the fixtures of every description, and let all movable lighter work, roof shingles (when used), mats (as used in Japan), &c., soak several days in the same solution. Where shingle roofs are used, let them be afterwards coated with lime, salt, and fine sand, or wood ashes.

Where houses are to be built, impregnate the main or thick timbers thoroughly with chloride of zinc, sulphate of copper, or borax, by pressure obtained as in Boucherising whilst the timber is green. Allow it to dry thoroughly before fixing, and paint the outside with silicate of soda three times when in position.

The lighter woodwork, shingles, &c., can be cut from large balks thus impregnated and afterwards washed superficially with silicate of soda, or this woodwork may be saturated by steeping in silicate of soda, chloride of zinc, or borax, but with a coat of silicate of soda outside all. By the use of the above comparatively simple and inexpensive remedies all complicated steam-pressure paraphernalia, vacuum pumps, &c., are avoided, the area of fires would be greatly reduced, whilst the insurance companies would be able to take risks which at present they refuse to do, even on stone buildings, if the roofs are of shingle. In Jamaica and other parts this is much felt. The general application of these precautions in many towns would permit of a

sufficiently large reduction on insurance premiums to of itself pay the interest on the initial cost of thus treating the timber used in our dwellings. We say nothing of the daily risks to life and property.

In the foregoing paper we have freely borrowed from every authority we could meet with, but the occurrence of fires in timber-built towns, destroying areas up to one and a half square miles at one fell swoop, must be our plea.—*Timber Trades Journal.*

THE PRESERVATION OF TIMBER.—The following is a summary of a voluminous report of the Committee of the American Society of Civil Engineers on the preservation of timber. The report itself was presented at the Convention of the Society at Deer Park, Md., June 24th.

After a brief statement of the labours of the Committee and of the evident necessity for the introduction of preserving processes on account of rapidly diminishing supplies of timber, a short history of the progress of the art is given, showing three principal methods of working, *viz.* :—(1), Steeping ; (2), Vital suction or hydraulic pressure ; (3), Treatment in closed vessels by steaming, vacuum, pressure, &c.

The experience in the United States is given in five tables, comprising the results, more or less conclusive, of 142 authenticated trials or experiments. In each case these are referred to at more or less length in the text, sufficiently to give the reasons for success or failure and the lesson taught. The five heads corresponding to the tables are :—(1), Kyanising, or use of corrosive sublimate ; (2), Burnettising, or use of chloride of zinc ; (3), Creosoting, or use of creosote oil ; (4), Boucherie, or use of sulphate of copper ; (5), Miscellaneous, or use of various substances.

Of the first Kyanising, it is stated that an absorption of four or five pounds of corrosive sublimate per 1,000 feet board measure, is considered sufficient, and it would now cost about 6 dollars per 1,000 feet. It is not recommended except in situations where the air can circulate freely about the wood, as in bridges and trestles ; but in very damp locations—as for ties when in wet soil and pavements—its success is doubtful. Its cost when first used led to cheating, which for a time brought discredit upon it.

Burnettising the Committee do not consider the best adapted to use where the timber is exposed to the washing action of water, as this removes the preservative ; but, on account of its cheapness, it is probably to be preferred at the present time to any other process for the preservation of railroad ties. The Wellhouse, Thilmany, and other modifications of the process aim at making the chloride insoluble, but are yet on trial. This

process has been largely and successfully introduced in Germany. Experience shows the life of softwood ties to be doubled and trebled by its use. Its cost in this country is about 5 dollars per 1,000 feet board measure, or 20 cents to 25 cents per tie, and for the latter purpose the Committee particularly recommend it. The work must be well done; but some of the failures were from doing it too well—that is, from using solutions of too great strength, thus making the timber brittle. A solution of 2 per cent., by weight, of chloride of zinc in water, is recommended.

Creosoting, or the injection of timber with hot creosote oil in a cylinder under pressure, is considered to be the very best process which has been fully tested, where expense is not considered. It is as yet the only one known which is sure to prevent the destructive attacks of the teredo or other marine animals, and to give absolute protection against decay in very wet situations. It is a somewhat expensive process, requiring for protection against the teredo from 10 lbs. to 20 lbs. per cubic foot of timber, and costing from 12 dollars to 20 dollars per 1,000 feet board measure. For resisting decay alone a cost of 10 dollars to 14 dollars is sufficient.

The Boucherie process, in which green timber is impregnated with sulphate of copper, either by vital suction, hydraulic pressure, or a vacuum, when well done, using a solution of 1 lb. of sulphate to 100 lbs. of water, has proved fairly successful. Under the head of "Miscellaneous" are classed 41 experiments with almost as many substances, sulphate and pyrolignite of iron, lime, resin, oil, tar, &c., but with as yet no commercial success. The general principles laid down are, to select the process with reference to the subsequent exposure. Use open-grained, porous timber, and for that reason in general the cheaper woods. Extract the sap and water to make room for the material to be injected, natural seasoning, except for the Boucherie process, being very desirable. Steaming takes the place of seasoning. Use enough of the antiseptic to ensure a good result, and then let the timber dry before using, as its durability will thus be increased. Do not hasten the work if it is to be well done. Protect ties or timber in the track as far as may be from water by drainage. Contract only with reliable parties of established reputation, under a skilled inspector, who must be in constant attendance when the magnitude of the order warrants.

There is at the close a discussion of the question, Will any preserving process pay? This is answered in the affirmative. The Chairman of the Committee gives a careful estimate in one of the appendices in an actual case in this country; another general estimate is given based on European experience, and three other separate appendices give different methods of examining the question of economy and comparing values. Other

appendices—to the number of twenty in all—treat of the general question of destruction and conservation of forests, and give reports of the personal experience of a number of engineers, with methods pursued, apparatus used, &c.—*Timber Trades Journal.*

CUSCUTA CREEPER.—Sir,—I have the honor to enclose copy of a report from the Acting Director of Woods and Forests, on the *Cuscuta* creeper, and on the steps taken in view of its destruction—which was read and considered at a meeting of the Woods and Forests Board held on the 12th instant.

The Board requested Mr. Scott to use his best endeavours to destroy the *Cuscuta* as fast as he can on Crown lands, taking if necessary some additional men to help the present members of the staff so as to secure their more rapid destruction. And, whereas, according to Mr. Scott's report, the proprietors of "*Alma*" and "*Bar-le-Duc*," which now form one and the same estate, are the only proprietors who seem to have taken steps for its destruction on private property. The Board further suggests that His Excellency the Governor be pleased to consider whether it would not be desirable to enact an Ordinance directing private proprietors to destroy the *Cuscuta* creeper on their property, and in case of default by them so to do—within a reasonable delay—authorizing the officers of the Woods and Forests Department to enter their property, except private dwelling-houses, and to destroy the creepers at the proprietor's expense.

I have the honor to submit these recommendations for His Excellency's favourable consideration.

V. NAZ, *Chairman,*

15th January, 1885. *Woods and Forests Board.*

To The Honourable the Colonial Secretary.

As you requested, I beg to submit for the information of the Board a report on the *Cuscuta* creeper.

This parasitical creeper belongs to the Convolvulus family (*Convolvulaceæ*), and is known by the common name of Dodder. There are seven or eight different species, but as I have not as yet examined the flower I am unable to say at present what species we have in Mauritius, and I have been informed that there is more than one. There are three or four different species indigenous to Europe and the temperate parts of Asia. It is also found in Russia, where it does great damage to the flax crop.

It is difficult to say in what way it was introduced into Mauritius, but most likely with foreign seeds. I have not found, I believe it was seen at Quartier Militaire in 1882, and the rapidity of its growth accounts for its now being so abundant.

I has been found in the Districts of Moka, Plaines Wilhems and Grand Port.

Here is an extract which throws some light on the method by which the *Cuscuta* first becomes attached to the plant on which it grows. "The seed germinates in the soil in the usual way, and by the long spiral-like germ makes one or two tight coils around its future support, and during the time these coils are progressing the foster parent is increasing in size. The compressing of the former around the latter becomes tightened, the causing the bark of the foster-parent to become more delicate, while the parasite is preparing a series of seral roots to penetrate it. It having done this, its position is firmly established. Its own natural root dies away, and thenceforward its true parasitic growth is astonishingly rapid."

It will thus be seen the great difficulty there is in exterminating it, for, should even half an inch of the stem be left on the branch of a tree it will again grow and increase; therefore the only plan to adopt is to cut down the branches and burn or bury the whole.

No trees have as yet been seen killed by it, but I saw on the Reserves of River Moka some Framboises Marronnes which appeared to have been killed by it. It has been proved that it has been spread to a great extent by the Indians carrying it from one locality and throwing it on to trees in another, under the false idea that it was the *Liane sans fin* (*Cassytha filiformis*) which they use as a medicine in certain cases.

There are at present three forest keepers employed in clearing it out where it is most abundant. It is intended to send six other keepers to assist in exterminating it.

The only Estates that are clearing it from private forests as yet are "Alma" and "Bar-le-Duc," and I should suggest that a forest keeper be sent to work along with the men sent for the purpose of clearing it away.

WILLIAM SCOTT,

12th January, 1885. *Acting Director, Woods and Forests.*

To The Chairman of the Woods and Forests Board.

I would add that the *Cuscuta* is not without its medicinal qualities, and the juice of the fresh plant is prescribed in sub-inflammatory complaints, and the powder of the dried plant is strewed on fresh wounds, the healing of which it is said to promote.—W. S.

The above Minute was referred to the Law Committee.—*Mauritius Mercantile Record.*

CUSCUTA REFLEXA.—In the "Indian Forester" for January 1886, I find the following paragraph regarding the *Cuscuta reflexa*:—

"The Government of Mauritius has addressed the Govern-

ment of India in order to ascertain from the Indian Forest Department what information is available regarding injuries to trees in India by the *Cuscuta reflexa*, or by other species of *Cuscuta* growing parasitically, and we hope that the question may be dealt with by some of our readers, and that we may have some valuable notes to communicate on the subject. Our own experience only points to injuries to orchard and road side trees, as the *Cuscutas* do not generally attack trees growing in masses, except perhaps in the case of scrub *zizyphus* jungle ; but we shall be much obliged for any information gathered from the personal observation of any of our readers."

I have travelled about in nearly every part of India, and having made botany a pet subject, I have been able to gather together many "notes" regarding plant-life in this vast Empire. Among my notes I find that, in nearly every province or Presidency visited by me, the *Cuscuta* was found growing everywhere in great luxuriance. It is well known to the natives, particularly in the Upper Provinces, as a most destructive parasite, and every means are taken to destroy it. It is unfortunately so tenacious of life that a single twig, if allowed to remain upon a tree, will immediately follow the divine law to "increase and multiply." It grows with great rapidity, and I have invariably found that a tree once attacked by it, is irretrievably lost. It is not at all particular as to what tree it may chance to grow upon, but as sure as it attacks a tree, it literally *strangles* it. I have seen it on fine specimens of *Millingtonia hortensis*, which have withered and died within a short space of time. The *Zizyphus* section of the N. O. *Rhamnaceæ* are particularly favoured of this parasite. I have observed that birds have a great deal to do in its spread, especially parrots, which when feeding on the fruit of the *Zizyphus Jujuba* infested with the *Cuscuta*, generally manage to get their claws entangled in the succulent tendril-like branches of the parasite, and thus carry away pieces and drop them on other trees. The editor of the "Indian Forester" says that "the *Cuscutas* do not generally attack trees growing in masses."* My experience is just the reverse ; and, as far as Calcutta is concerned—to go no further—any one by walking through the Eden Gardens, or for the matter of that, the Dalhousie Square gardens, may see the obnoxious weed strangling whole clumps and borders of *Crotons*, *Dracænas*, *Eranthemums*, *Ixoras*, &c. The *Millingtonias* along the *maidan* are similarly infested. The variety generally seen about here is the *C. reflexa*. In the forests of Sikkim and Nepal the *C. verrucosa* and *Hookeri* are generally found. In the Doon forests I have seen the *C. Hookeri* covering acres of trees. In the Punjab it is very prolific. The "Bir" round about Hissar, and in the Rohtak division, which chiefly consists

* We should have said masses of *forest* trees.—[ED.]

of the *Capparis horrida*, ("Karreel" bush,) the *C. reflexa* may be seen thriving in great luxuriance. The *Dhâk* forests (*Butea frondosa*) of the Patna division are literally covered with *C. reflexa*. It is my opinion, founded upon long experience, that the injury done to forests and fruit trees by the *Cuscutas* must be very great, and if statistics were obtained, it would be found that they exercised a very wide influence prejudicial to the healthy growth of forest trees. The only remedy I can suggest is that, no sooner it is observed on a tree, endeavours should be made at once to have it plucked off, and burnt, for if once allowed to spread, it will give a great deal of trouble to exterminate it. Even at the risk of lopping off branches of the trees upon which the *Cuscuta* is found growing, it should be removed.—S. H.—*Indian Agriculturist.*

ISLAND OF TERNATE.—The effects of forests upon the general healthfulness of the State is great. The philosopher, Boyle, long since stated that in the Dutch East Indian island of Ternate, long celebrated for its beauty and healthfulness, the clove trees grew in such plenty as to render their product almost valueless. To raise the price of the commodity most of the spice forest was destroyed. Immediately the island—previously cool, healthy, and pleasant—became hot, dry, and sickly, and unfit for human residence. It is well known that the general clearing away of the forests in this country has had a tendency to raise the temperature in summer.—*New York Report of the Commission of State Parks.*

ACCORDING to experiments by M. Senff, the yield of crude pyroligneous acid, tar, charcoal, and gas is almost the same with the most different woods. But the richness of the acid waters in acetic acid, and consequently the yield of dehydrated acid, vary greatly. In this respect the wood of coniferous trees is the least valuable. The wood of the trunk furnishes more acid than that of the branches. The wood yields more acid than the bark, and sound wood more than dead wood. Rapid calcination yields more gas at the expense of the condensed products and of the charcoal; it yields also the weakest acid waters, and the charcoal is more hygroscopic than that furnished by a gradual action.—*Timber Trades Journal.*

A correspondent enquires by what rules or authority is the "Indian Forester" sent "On H. M.'s Service" with Service stamps? The "Indian Forester" is a private journal, and has nothing to do with Government. But he forgets that the Roorkee Press, which publishes the paper, is under Government management, and can clearly use Service stamps, charging the postage regularly in its accounts with the "Indian Forester."

THE

INDIAN FORESTER.

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We congratulate the Forest Department, Madras, on the fact that Mr. H. A. Sim, C.S., Deputy Conservator of Forests, 1st grade, Kurnool, has been appointed to officiate as a Secretary to the Board of Revenue, Madras.

As all forest business in Madras passes through the Board of Revenue, it cannot but prove beneficial to the interests of forest conservancy that one of the Secretaries to the Board should have a practical knowledge of forest management.

It is still a prevailing idea with some administrators in India, that no special training is required for forestry, and senior Civil officers frequently criticise forest operations freely, though they would not venture to do so in the case of a Surgeon amputating a limb.

It may, however, be seen from Mr. Thiselton Dyer's evidence before the Parliamentary Committee on Forestry, that the new Director of the Kew Gardens does not share this opinion, and the relations between Local Governments and Forest officers would be greatly improved, if one of the Assistant Secretaries to the Government were either an experienced Forest officer, or a Civilian who, like Mr. Baden-Powell or Mr. Sim, has served for several years in charge of executive forest work.

AFFORESTATION IN GREAT BRITAIN AND IRELAND.*

Introduction.

The question of afforestation in Great Britain and Ireland has, for some years past, received special attention. Various papers have been published setting forth the inadequacy of the British woodlands, and the uncertainty which prevails as regards future supplies of timber. Dr. Robert Lyons, late member of Parliament for Dublin, has specially taken up the afforestation of Ireland, as he believes that it will act beneficially in various respects. The Select Committee of the House of

* Reprint of a paper written at the request of the Lord Lieutenant of Ireland.

Commons on Industries (Ireland) investigated the question, and examined Mr. D. Howitz, whose evidence will be found at pages 253–295 of the Report of the Select Committee, printed by order of the House of Commons in July, 1885. Another Select Committee of the House of Commons was appointed last summer, on the motion of Sir John Lubbock, member of Parliament for the University of London, with the object of considering whether, by the establishment of a Forest School or otherwise, the British woodlands could be rendered more remunerative. This Committee examined Mr. William G. Pedder, Colonel James Michael, C.S.I., Dr. Hugh Cleghorn, Colonel G. Pearson, Mr. W. T. Thiselton Dyer, C.M.G., and Mr. Julian C. Rogers, whose evidence is recorded in the Report of the Committee, printed by order of the House of Commons in July, 1885.

I have, during the last six months, visited various parts of Great Britain and Ireland in connexion with the establishment of an Indian Forest School at the Royal Indian Engineering *College, Cooper's Hill, and I have been strongly urged to give* my views on the question of afforestation, especially with reference to Ireland. Although I have not yet seen enough to deal with this large subject in detail, I propose to offer a few remarks in so far as personal inspection and past experience in my profession in Europe and India justify me in doing. If the question should come to a practical issue, it will be necessary to investigate it in much greater detail, than has yet been done.

I.—General considerations.

Forests are, in the economy of nature and of man, of direct and indirect value; the former through their products, and the latter through the influence which they exercise upon climate, the regulation of the water supply, the healthiness of a country, and allied subjects. The principal points are, without going into full detail, the following:—

(1). Forests supply timber, fuel, and other forest products.

(2). They provide work, and tend to produce a variety of industries.

(3). They tend to reduce the temperature of the soil and the air, *and to render the climate more equable.*

(4). They increase the relative humidity of the air, and probably reduce evaporation.

(5). They tend to increase the rainfall.

(6). They regulate the water supply, insure a more sustained yield of springs, reduce the violence of sudden floods, and render the flow of water in rivers more continuous.

(7). They prevent landslips, the formation of avalanches, the silting up of rivers, and they arrest moving sand.

(8). They reduce the velocity of winds, and afford protection to adjoining fields.

(9). They afford shelter to cattle and to useful birds.
(10). They assist in the production of oxygen, and especially of ozone.
(11). They may, under certain conditions, improve the healthiness of a country, and, under others, reduce it.
(12). Finally, they increase the artistic beauty of a country.

2. It is not intended to give here the details upon which these conclusions rest; I hope to do this on another occasion, and I shall now only state that nothing has been included in the above twelve points which is not supported by accurate observations.

1. *Direct Effects of Forests.*

3. As regards the direct effects of forests, mentioned above under first and second, the most important points for consideration are :—

(*a*). The position of a country, its communications with other countries, and the control exercised by one country over others.
(*b*). The quality and quantity of substitutes for forest products available in a country.
(*c*). The value of land and labour, and the return which land yields as field, grass-land, or forest, respectively.
(*d*). The density of population of a country.

4. A country which is so situated that the importation of wood and other forest products is comparatively easy and cheap (sea-bound, or traversed by navigable rivers coming from a country rich in forests, or intersected by numerous railways and other means of communication), or which has control over other countries, especially colonies, rich in forests, can dispense with extensive forests. In a country, which is rich in coal, lignite, or peat, the production of firewood is of subordinate importance. Where iron or other substitutes for timber in sufficient quantity and at a low rate are available, forests are not required to the same extent as in a country which does not enjoy such advantages. Where land under cereals or grass yields, even if forest produce is imported, more valuable returns (higher interest on capital) than under forest, the latter would, in this respect, be out of place. If the population of a country is very dense, and all land is required for the production of food, forests will not find a place. Where, on the other hand, waste lands exist which are not required or are unsuited for cultivation and grass-lands, and where the population is in want of additional work, it may be advisable to create forests, and thus provide occupation through the operations connected with the administration of the forests and the industries, which the existence of forests tends to create.

2. *Indirect Effects of Forests.*

5. In considering the indirect effects of forests, the most important factors are the climate and configuration of a country. The nearer to the equator, the more important becomes, as a rule, the forest question, and the further north the less important. While forests may in a hot country, with distinct wet and dry seasons, be absolutely necessary for the mitigation of extreme heat and dryness during certain parts of the year, and the regulation of the flow of water in springs and rivers, they may be injurious in a northern country, which is already too cold and damp. Similarly, a continental country may require forests, while a sea-bound country may be better without them, as far as climatic considerations are concerned. A mountainous country is much more in need of forests than a level country, on account of their beneficial action as regards landslips, avalanches, the carrying away of débris, the silting up of rivers and low lands, sudden floods, and the sustained feeding of springs. The action in this respect is produced in the following manner :—

(1). The branches and leaves of the trees break the force of the falling rain, and retain a portion of it which evaporates.

(2). The covering of forest soil and the roots of the trees prevent the gliding down of earth and rock, and the formation of avalanches on hill sides.

(3). The covering of forest soil (humus or leaf-mould, mosses, shrubs, &c.) possesses in a high degree the faculty of absorbing water and of retaining it for a time. It has, for instance, been proved that mosses of the genus Hypnum absorb three and a half to five times their weight of water, and peat mosses of the genus Sphagnum even nine times their weight, while the leaf-mould found in a middle-aged, well-stocked and well-preserved beech forest is capable of retaining, for a time, 5 inches of rain. The water thus absorbed reduces the quantity which rushes down sloping ground during rain ; it partly penetrates into the ground, and the rest is slowly given up. Well-preserved forests, with a good layer of leaf-mould, act, therefore, like huge water reservoirs, which increase the quantity of water penetrating the soil, and which render the flow of water in rivers less fluctuating.

6. As regards the protection against strong winds, and shelter to cattle and useful birds, forests act beneficially in any country.

7. In applying these facts to Great Britain and Ireland it should be remembered, that the climate and rainfall of these countries is principally governed by their insular position, which exposes them to strong air currents coming direct from the sea.

Compared with their effects, those of forests, even if they occupied 20 per cent. of the total area, would be comparatively small. Again, by far the greater portion of the waste lands in Great Britain and Ireland is covered with heath, and a considerable portion with peat mosses, which are most powerful agents in the retention of water ; moreover afforestation would, in many cases, be accompanied by the draining of the soil, which would counteract the effects of forests ; hence afforestation in these islands would not produce, comparatively, the same effect, as in a country where unafforested soil has generally no covering.

3. *Area of Forests.*

8. No general rule can be laid down showing whether forests are required in a country, or what percentage of the area should be so stocked. The forest question must be determined on the *special circumstances of each country*. *Dr. Lyons published* a short time ago a statement showing the latest estimates of the forest areas in a number of countries, which I reproduce below. Some of the data require confirmation, but on the whole they give a fair idea of the areas. I have added two columns showing the percentage of the total area of each country under forest, and the forest area per head of population :—

<table>
<tr><th rowspan="2">COUNTRY.</th><th colspan="2">AREA IN SQUARE MILES.</th><th rowspan="2">Percentage of Total Area under Forest.</th><th rowspan="2">Area of Forest per Head of Population, in Statute Acres.</th></tr>
<tr><th>Total.</th><th>Under Forest.</th></tr>
<tr><td>Russia in Europe, ...</td><td>1,944,324</td><td>824,104</td><td>42</td><td>6·1</td></tr>
<tr><td>Sweden, ...</td><td>157,055</td><td>66,197</td><td>42</td><td>9·1</td></tr>
<tr><td>Austria Proper, ..</td><td>108,420</td><td>36,376</td><td>34</td><td rowspan="2">1·2</td></tr>
<tr><td>Hungary, ...</td><td>130,008</td><td>35,179</td><td>27</td></tr>
<tr><td>Germany, ...</td><td>207,931</td><td>53,409</td><td>26</td><td>0·8</td></tr>
<tr><td>Norway, ...</td><td>119,870</td><td>29,563</td><td>25</td><td>9·9</td></tr>
<tr><td>France, ...</td><td>203,996</td><td>35,450</td><td>17</td><td>0·6</td></tr>
<tr><td>Belgium, ...</td><td>11,376</td><td>1,677</td><td>15</td><td>0·2</td></tr>
<tr><td>Italy, ...</td><td>114,362</td><td>14,111</td><td>12</td><td>0 3</td></tr>
<tr><td>Holland, ...</td><td>12,515</td><td>832</td><td>7</td><td>0·1</td></tr>
<tr><td>Denmark, ...</td><td>13,396</td><td>623</td><td>5</td><td>0·2</td></tr>
<tr><td>Great Britain & Ireland,</td><td>120,312*</td><td>4,360†</td><td>4</td><td>0·1</td></tr>
<tr><td>Total, ...</td><td>3,143,565</td><td>1,101,881</td><td>35</td><td>...</td></tr>
<tr><td>United States of America, ...</td><td>3,580,242</td><td>593,750</td><td>17</td><td>7·6</td></tr>
</table>

* This is the figure given by Dr. Lyons ; it does not quite agree with those found further on.

† Dr. Lyons gives only 4,009 square miles ; he has apparently omitted the woodlands of Wales.

9. It has been estimated that the percentage of land under forest required for a country situated and populated like the centre of Germany, may be put down at about 25 per cent. of the total area. Judging by this standard, and assuming that the data given in the above table are approximately correct, it would appear that Russia and Sweden have as yet more land under forest, than is absolutely required. Denmark and Great Britain and Ireland have a very small percentage of land under forest, but they are not only sea-bound, but also situated under a northern latitude, and it would be premature to conclude at first sight, that their forest areas are too small.

10. Great Britain and Ireland are well supplied with coal and peat, and the production of firewood is of very little importance; as a matter of fact, firewood is unsaleable in many parts of the country. The question of the supply of timber requires a more detailed notice. Although the production of iron is enormous, the imports of wood into Great Britain and Ireland are stated to have amounted in 1883 to 6,447,211* loads. For the same year the value of home production and imports of forest produce are given, in round figures, as follows:—

	£
Estimated value of wood produced in the country,	3,000,000
Value of imported wood, ...	18,000,000
Total value of wood, ...	21,000,000
Value of minor† forest produce, as bark, dye woods, wood pulp, galls, turpentine, pitch and tar, resin, lac, gum, caoutchouc, gutta percha, fibres, &c., imported, ...	14,000,000
Grand Total, ...	£35,000,000

The total value is equivalent to about one pound per head of population, per annum.

11. It appears that of the total quantity of timber required by the country, only about one-seventh (according to value), is produced at home. If the whole of the required timber were to be grown locally, it would be necessary to increase the area under forest to about 20 per cent. of the total area of the country, or, say, to 24,000 square miles. A considerable portion of the imports consists, however, of teak, fancy woods, &c., which could not be grown in these islands. Still, after making allowance for these, an area of about 20,000 square miles, or nearly five times the present area, would be required.

12. The question of the future timber supply comes to this:— "Is it necessary or advisable to increase the area under forest in Great Britain and Ireland, with the view of meeting future

* Simmons, in the *Journal of the Society of Arts*, 19th December, 1884.

† In Forest terminology, *major produce* means wood (timber and firewood); *minor produce*, all other articles obtained from forests.

requirements of timber, or can colonies and other countries be relied on to meet the demand?" This question has been extensively discussed of late, and I shall restrict my remarks to the most obvious point, the supply of those ordinary kinds of timber, which will readily grow in the climate of these islands.

13. Of the 6,447,211 loads of wood imported in 1883, the following quantities came from the more important sources:—

		Loads.
From	Sweden, ...	1,600,000
,,	Russia, ...	1,350,000
,,	Norway, ...	750,000
,,	Germany, ...	430,000
,,	The United States of America, ...	400,000
	Total, ...	4,530,000
	Canada, ...	1,540,000
	Grand Total, ...	6,070,000

In round figures, Great Britain and Ireland received one and a half million loads from the Dominion of Canada, over which the Government of this country has a certain control, and four and a half million loads from countries over which it has no control. Although these data refer only to one year, 1883, they approximate to the average imports of the last five years sufficiently close for the present argument. As far as the available information goes, it seems almost certain, that the supply from the United States of America will die away at an early date, thus reducing the available quantity by 400,000 tons. Of the foregoing European States a sustained yield is at present only secured from Germany, where the bulk of the forests is under systematic management and control; indeed, it is believed that the imports can easily be increased, especially from the forests in East Prussia. In Sweden, Norway, and Russia, the forest conservancy measures so far introduced do not, if I am correctly informed, ensure a sustained yield of the quantities removed of late years, though the falling off in the supplies may not be so rapid as has been assumed. These sources, then, cannot be relied on to furnish for any length of time 3,700,000 loads annually, or more than one half of the total imports, even if the supplies from Germany should somewhat increase. None of the other large European countries will materially help to cover the deficiency, any surplus material available in Austria being required by France and other countries.

14. Canada has sent about one and a half million loads annually, but gloomy reports have been received of the extensive destruction of forests in that country. The matter is said to receive now attention, and if, as has been stated, the area of timber lands has been reduced to less than 10 per cent. of the total

area, it is high time to take energetic steps towards the introduction of proper forest conservancy measures and the reproduction of the forests. Large areas, otherwise not required, are available for the purpose, and the Government of England should use all possible influence to bring about the setting aside for forest purposes of suitable areas on a large scale.

15. In how far South America and Africa can make good any deficiency of timber in Europe, is not known at present. Australia can probably do very little in this respect. The imports from India have hitherto been restricted to that of teak (maximum 45,000 loads) and of a small quantity of fancy woods. As the price of timber rises, with decreasing supplies, other kinds of useful timber may be added, but the expenses will always be comparatively high, apart from the fact, that India is likely to require as much timber as it produces.

16. On the whole, although I am far from joining those who would create a panic on the timber supply question, there is every prospect, that any woods now planted in Great Britain and Ireland will yield a fair return, by the time that they are ripe for the axe. At present prices are very low, but that should not induce the present generation to disregard the future. Wood is an article which requires a long time to mature, and forethought as regards future supplies of it is more necessary, than in respect of any other article.

17. From the Agricultural Statistics of 1884 and 1885, I gather that the area of Great Britain and Ireland is distributed as follows :—

Division of Land.	Area in Square Miles.				Percentage of Total Area.			
	England and Wales.	Scotland.	Ireland.	Total.	England and Wales.	Scotland.	Ireland.	Total.
Under crops, including meadows, orchards, gardens, and grass lands,	43,687	7,585	23,818	75,090	74·9	24·9	73·2	61·9
Woods and forests,	2,545	1,296	519	4,360	4·4	4·3	1·6	3·6
Barren mountain land, bog, marsh, waste land, roads, water, fences, &c.,	12,079	21,536	8,194	41,809	20·7	70·8	25·2	34·5
Grand Total, ..	58,311	30,417	32,531	1,21,259*	100	100	100	100

* This is the area given in the Agricultural Statistics.

The Director-General of the Ordnance Survey has kindly furnished me with the following figures :—

England and Wales, ...	... 59,469	square miles.
Scotland, ...	... 30,902	" "
Ireland, ...	... 32,531	" "
Total,	... 122,902	" "

These figures include all water and foreshores.

The total area of all waste lands amounts to 41,809 square miles. I am not in a position to state, at present, what proportion of this area is fit and available for forests, but on the whole it may perhaps be estimated at one-half, or 20,000 square miles, in round figures. At any rate it is evident that there is sufficient room for a considerable extension of the woodlands in Great Britain and Ireland.

4. *Forests as objects of Industry.*

18. Forests are important objects of industry; they require labour in their creation, preservation and the removal of the produce. A great variety of occupations depends on the products of forests as their prime materials—not only as regards construction, manufacture, furniture making, &c., and the industries, using minor forest produce, which would be in existence in any case, whether the material is imported or produced locally—but also as regards special industries, which cannot spring into existence except in and around large forests with a sustained and regular yield. The articles produced by the latter are now mostly imported, but they could, to a considerable extent, be made by local labour, if Great Britain and Ireland had extensive forests.

19. The quantity of labour required for forest operations varies with the value of the products, and the consequent greater or less minuteness of the system of management. The number of persons required for the ordinary work in the forests, administration, creation, preservation, cutting of wood, and collection of minor products, has, for forests situated like those of Germany, been variously estimated at one adult labourer for every 100 to 500 English acres. This estimate refers to forests already in existence, in which, perhaps, one per cent. of the area is annually cleared and re-stocked, and a great portion of which is of small value. For Great Britain and Ireland it may be assumed, that about one adult labourer will be required for every 100 acres, after the forests have been created; while the initial planting work is going on, about every 15 to 20 acres would supply work for one labourer throughout the year, what with preparation of the soil, draining, nursery work, planting, sowing, fencing, &c. Assuming that the forest area of Great Britain and Ireland were, during the next 20 years, increased from

4,360 to 20,000 square miles, it would be necessary to plant annually some 500,000 acres, which would fully occupy at least 25,000 labourers, corresponding to a population of 125,000 people. After the forests had been created, they would give employment to about 100,000 labourers, corresponding to a population of half a million. Large as these figures are, it will be seen, that forests give but small employment when compared with agriculture, and it follows that, ordinarily, all lands required for agriculture could, as regards the labour question, not be made available for forests. The latter must be restricted to surplus areas or to lands not suited for agriculture, as long as the forest products are obtainable at a reasonable rate from outside sources.

20. Before leaving this subject, the following information may find a place here :—Prussia, Bavaria, Saxony, Wurtemberg, Baden, and Alsace-Lorraine, have a combined population of 40,644,736 people. The labour connected with the forests of these countries, and their products, has been estimated to be worth :—

	£
Labour in the forests, ...	4,550,000
Carriage of wood, &c., ...	3,900,000
Collection of minor products, ...	1,000,000
Total, ...	9,450,000

These earnings suffice for the maintenance of about 300,000 families, or one and a half million people. It has further been estimated that the prime material yielded by the forests occupies about four millions people, so that forests and industries dependent on them provide work for some seven millions people, or one-sixth of the total population of the above mentioned countries.

5. *Forest Revenue.*

21. Although it is not intended to discuss here in full detail the revenue obtainable from forests, it will not be out of place to offer a few remarks on the subject. It has been put forward, from various quarters, that forests in England can be made to pay better than land under cultivation. This may be the case under very special conditions, but generally I do not believe it to be possible. Data have been produced showing that land under forest has yielded higher returns than would have been obtained by letting the land for agricultural purposes, but in these cases it has generally been overlooked, that the return in the one case represents the interest on a much higher capital than in the other. This can best be explained by an example, which I shall, for convenience sake, make as simple as possible. Assuming that certain land yields, if let for agriculture, 6*s.* an acre a year ; the

purchase value of this land would be £10 an acre, calculating with 3 per cent., and this is the capital of which 6*s.* represents the annual interest. If the land is, instead of letting it, put under forest, it will yield no return for a series of years, and, in addition, a certain sum must be spent in creating the forest; both items with their compound interest must be added to the invested capital. Ordinarily newly created forests must be closed for, say, 30 years, during which time they yield little or no return. Assuming that the returns from thinnings made between the 30th and 50th year cover the expense of maintenance for the whole 50 years, and that the full returns commence with the 50th year, a most favourable and rare case, the account would stand as follows, at the end of 50 years :—

	£	s.	d.
Value of land, per acre, with compound interest at 3 per cent. for 50 years— $S = 10 \times 1{\cdot}03^{50}$	43	16	9
Value of outlay on the creation of the forest, say £3 per acre— $S = 3 \times 1{\cdot}03^{50}$	13	3	0
Total, ...	56	19	9

In a round sum, £57 represents the forest capital, and if the concern is to yield 3 per cent. on the invested capital, the returns from the forest must amount to £1 14*s.* 2*d.* an acre a year, or nearly six times the rent obtainable by letting the land. Except under very special circumstances (osier beds, &c.), such returns will not be obtained, and I am satisfied that, ordinarily land fit for cultivation will, if used in this way, yield higher interest on the invested capital, than if stocked with wood.

22. I have experienced great difficulty in obtaining reliable data regarding the returns obtained from forests in Great Britain and Ireland. Inquiries made by me seem, however, to show, that the great forest estates in Scotland do at present not yield, on the whole, more than about 5 shillings an acre, which, at 3 per cent. interest and according to the above assumptions, corresponds to an average purchase value of the land equal to £1 10*s.* an acre, or an annual land revenue of about 11*d.* an acre. Some of the lands are, perhaps, not worth more, some even less, but the average value is decidedly higher, and a good portion would yield 10 and 20 times eleven pence a year, if let for agricultural purposes. The above-mentioned return of 5 shillings an acre does not include the receipts which some of the Scotch proprietors at present obtain by letting the land for deer shooting, but that is, it seems to me, a somewhat abnormal source of income, which may disappear as suddenly as it has sprung into existence.

23. It may be contended, that the price of timber is very low at present, and that it may and probably will rise as trade revives and foreign supplies of timber become exhausted. That may be so, but other items may also change, and it would be undesirable to rest a calculation on uncertain future events.

6. *Summary of Conclusions.*

24. In summing up these general considerations, the following principal conclusions may be drawn in respect of Great Britain and Ireland :—

(1). As the imports of wood and other forest produce are very great, and as it is doubtful whether sufficient supplies can be permanently obtained from other countries, the extension of the home forest area can be strongly recommended, provided it is carried out on surplus lands. The additional wood-lands may safely be expected to yield fair returns on the invested capital, if the work of creation and administration of the forests is done in an economic manner.

(2). The surplus area is so great, that extensive tracts can be set aside for forests, without trenching on the land required for agriculture (fields and grass lands).

(3). The tendency of the forests to reduce the temperature of the soil and the air, to increase the relative humidity of the air and the rainfall, is of subordinate importance in these islands, which are, owing to their geographical and sea-bound position, subject to influences, in comparison with which those of forests are small.

(4). The increase of the forest area will act very beneficially in reducing the effects of winds on adjoining lands under cultivation, and in affording shelter to cattle and useful birds.

(5). The extension of the area under forest will provide additional work, without interfering with existing sources of occupation.

I am not at present prepared to go beyond what has been stated in the above five points, but I believe it to be sufficient to show, that a fair field for judicious enterprise exists in the extension of the wood-lands of Great Britain and Ireland.

II.—The Afforestation of Ireland.

25. In the first part of this paper I have dealt with the forest question generally in respect of Great Britain and Ireland, and I shall now proceed to offer some remarks with special reference to Ireland, commencing with the consideration of the indirect effects of forests.

1. *Forests in relation to Topography and Drainage.*

26. Ireland has been described* as an island consisting of a great central plain, bounded near the coast by groups of mountains, though not entirely surrounded by them. Along the north, west, and south, the coast is deeply indented, and the central plain is intersected by numerous lakes and sluggish rivers, which find their way out to sea at the head of the bay and estuaries. A line drawn across the centre of the country from Dublin or Dundalk Bay, on the east, to Galway Bay, on the west, will meet with no higher elevation than that of about 250 feet above the sea, but a section in every other direction will be found to cross a mountainous ridge bounding at each extremity the central undulating plain. The mountains surrounding this plain may be divided into the following groups :—

(1). The north-western highlands of Donegal and Derry.
(2). The western highlands of Mayo and Galway.
(3). The south-western highlands of Kerry and Cork.
(4). The south-eastern highlands of Wicklow and Dublin.
(5). The north-eastern highlands of Mourne, Carlingford, and Slieve Gullion.

Many minor hill ranges exist, besides the above, but it would lead too far to mention them here in detail.

27. The central plain is described as being underlaid throughout the greater portion of its area by Carboniferous limestone, except near local disturbances. The limestone is only occasionally visible, as the greater portion of the surface is overspread by beds of limestone gravel, or boulder clay, or by shallow lakes and streams. Extensive peat mosses are a still more recent covering. It is believed that this limestone plain was originally covered throughout its area by coal measures, which denudation in the course of time has reduced to such an extent, that the originally vast Upper Carboniferous beds are now represented by only a few scraps left here and there. Coal-fields are found at Tyrone in the north, and at Killenaule and Castlecomer in the south.

28. The *north-western* and *western* highlands are formed of Lower Silurian beds generally converted by metamorphism into crystalline schists, quartzites, and gneiss. The highest elevation in these two ranges is reached at Muilrea, 2,688 feet above the sea. The *south-eastern* highlands are formed of Granite which penetrates Lower Silurian beds, the latter being considerably metamorphosed ; they rise to an elevation of 3,039 feet, at Lugnaquila. In the *south-western* highlands the rocks are disposed in long parallel bands, ranging nearly east and west. The narrower bands are formed of carboniferous rocks, the broader of Old Red Sandstone ; the former occupy the val-

* Hull, "The Physical Geology and Geography of Ireland," page 120.

leys and arms of the sea, the latter rise into mountainous tracts. These ranges include the loftiest elevations in Ireland, the ridge of Macgillicuddy's Reeks rising to a height of 3,414 feet above the sea. The *north-eastern* highlands are old volcanic, and remarkable for the number and variety of rocks and minerals which they possess; the highest elevation, Slieve Donard, is 2,796 feet above the sea.

29. Ireland is drained by 226 separate rivers, with numerous feeders. The following are the twelve largest drainage basins:—

	Drainage area, in square miles.
(1). The River Shannon, in the centre and west,	6,060
(2). The Suir, Barrow, and Nore, in the south-east, ...	3,555
(3). The Bann, Main, Moyola, Ballinderry, and Blackwater, with Lough Neagh, in the north-east, ...	2,242
(4). The Erne, in the north-west, ...	1,689
(5). The Blackwater, in the south, ...	1,284
(6). The Corrib, in the west, ...	1,212
(7). The Foyle, in the north, ...	1,129
(8). The Boyne, in the east, ...	1,040
(9). The Moy, in the west, ...	805
(10). The Slaney, in the south-east, ...	680
(11). The Liffey, in the east, ...	529
(12). The Lee, in the south, ...	484
Total, ...	20,709

These twelve basins drain about two-thirds of the total area, while the remaining one-third is divided amongst the other 214 rivers.

30. In addition to the rivers, Ireland has a large number of lakes, both situated amongst the mountains and in the plains. The largest of these is Lough Neagh, with an area of over 150 square miles, forming part of the Bann River drainage basin. The Shannon, in its course of 160 miles length, passes through a series of lakes; the Corrib and Moy include also large lakes in their drainage basins.

31. Although the principal mountains are grouped along the coast, Ireland has a distinct main watershed, low as it may be, which commences near Lough Foyle, runs through the centre of the country, and ends near Bantry. This low watershed divides the waters between the Atlantic Ocean and the Irish Sea.

32. After these premises I shall proceed to consider in how far afforestation is called for with reference to the regulation of moisture, and the prevention of floods and landslips. If Ireland was situated in a more southern latitude, or removed from the sea, its configuration would probably make afforestation a neces-

sity; but, owing to the existing climate of the country, all the waste lands in the lower part of the country, and along the lower and even portions of the higher parts of the hill ranges are naturally covered with a dense growth of heath, grass, and mosses, which act as most powerful retainers of moisture, and bind the surface soil together. Anyone, who has travelled in Ireland, must have noticed that this covering of the soil is, after rain, saturated with water to such an extent that the addition of trees would make comparatively little difference. Moreover, as already mentioned, afforestation would necessitate the artificial draining of a considerable portion of the land, and I am, in the absence of statistics on the subject, very doubtful whether the operation of afforestation would, on the whole, act beneficially as regards the regulation of moisture. The comparatively small additional effect of the forest growth would probably be neutralized by the draining of the soil.

33. The upper part of the hill ranges consists to a considerable extent of rock, much of which is at present bare. Here afforestation would probably produce some good effects, but the undertaking would never pay, and it could only be justified on public grounds, if the damage done by the rushing down of the rain water was great. I have, during my late tour in Ireland, seen traces of such damage, but on the whole, it is not much. The rock is generally sufficiently consistent to resist any appreciable eroding action of the rain water. To sum up, as regards the denudation of the hill sides, afforestation is, in my opinion, at present not called for; at any rate the question is neither urgent nor very important, as long as erosion is not artificially assisted by the act of man.

34. It has been stated above, that the rain water which falls in Ireland is carried into the sea by 226 separate river basins. Here, then, is already a great division of the waters, which in itself prevents the occurrence of catastrophes like those which were reported some years ago from the valley of the Rhone in France. Some damage is no doubt done, but I feel satisfied that it will be much cheaper to face the loss which is occasionally caused by inundation, than to attempt its prevention by the afforestation of rocky hill sides. A good deal of relief has already been given by engineering works, and more can, no doubt, be done in this way, where necessary, at an outlay much more commensurate with the effect, than if attempted by afforestation.

35. Much capital has been made out of the effects of forests on sudden floods, and the afforestation of Ireland has been strongly urged on this ground, the drainage area of Lough Neagh being used as an illustration. I regret that I cannot support what has been advanced in this respect, because the effects of forests in Ireland have been decidedly over-estimated. I shall attempt to illustrate this statement in the case of Lough Neagh.

The area of Lough Neagh is given as ...	153	square miles.	
" " drainage basin,	1,712	"	"
Total, ...	1,865	"	"
Proportion of lake area to total area, ...	1 : 12		

If one inch of rain falls within 24 hours, and one-third of it sinks into the ground or evaporates, while two-thirds reach the lake within 24 hours, the level of the lake will be raised by 8 inches minus what is taken away by the Lower Bann, or say 6 inches. Supposing 100,000 acres, or about one-twelfth of the drainage area, was planted with forest, and these planted areas retained twice the quantity of water, two-thirds of the fall instead of one-third, the level of the lake would thereby be reduced by $\frac{8}{12 \times 2} = \frac{1}{3}$ of an inch. If 250,000 acres were planted, equal to about 20 per cent. of the total area, the reduction of the level of the lake would amount to $\frac{1}{3} \times \frac{5}{2} = \frac{5}{6}$ of an inch. In reality, however, the effect would be much smaller for the reasons given above, and I doubt whether the planting of 500,000 acres, or about 40 per cent. of the total area, would, during a fall of rain of one inch within 24 hours, reduce the level of the lake by more than one inch. Moreover, it is, in several instances, not clear to me how the areas to be planted are to be obtained. It has, for instance, been proposed to plant in the basin of the Upper Bann river an area of not less than 51,200 acres (80 square miles), but I find that the whole county Down contains only 51,158 acres of waste lands. Assuming that of this area 30,000 acres are situated in the Upper Bann drainage basin, and that of these 20,000 acres are found fit for planting (a most favorable proportion); it would be necessary to take at least 30,000 acres out of the grass or cultivated lands, an inroad on the food and fodder resources which could scarcely be justified or approved. Armagh, again, which adjoins county Down, and is situated in the Blackwater drainage basin, has only 15,739 acres of waste lands, and here also planting could only be done on a limited scale. On the whole, I believe that it will be wise to leave the case of Lough Neagh, for the present, in the hands of the engineer.

36. I trust that I shall not be misunderstood. Where unafforested waste lands are generally bare of vegetation, afforestation will have a powerful effect, but where such lands are covered with a growth of heath, grass, and mosses, as in Ireland, an effect similar to that produced by afforestation is already in existence, and the addition of trees will not appreciably increase it, especially if the planting must be accompanied by the artificial draining of the ground. I fully believe in the beneficial effects of forests on the regulation of water as a general principle, but I demur to the application of that principle without due consideration of the special circumstances of each country.

2. *Forests in relation to Climate.*

37. Ireland is situated between the 51st and 56th degrees northern latitude, and the 5th and 11th degrees western longitude; it is surrounded on all sides by the sea, and subject to strong wind currents, more especially along the western coast. The Agricultural Statistics of Ireland for 1884, contain detailed data regarding meteorological observations made at Dublin (at 51 feet above the sea), during the years 1864 to 1884, from which I have compiled the following table :—

Season.	Annual Average of 20 Years' Observations, 1864-84.			Observations of 1884 only.		
	Temperature, in Degrees Fahrenheit.	Number of Rainy Days.	Rainfall, in Inches.	Barometrical Pressure, in Inches.	Tension of Vapour in the air, in Inches.	Relative Humidity of the air, in Per cent.
Spring, ...	46·9	46·6	6·048	29·873	·260	77·4
Summer, ...	58·4	47·8	7·338	29·980	·393	76·8
Autumn, ...	49·3	48·5	7·626	30·068	·313	84·0
Winter, ...	41·4	51·7	7·003	29·845	·238	84·5
Mean or Total of Year, ...	48·9	194·6	28·015	29·942	·301	80·7

The temperature, measured 4 feet above the ground, is given as deducted from the maxima and minima readings of the thermometer by Kaemtz's formula :—

[Min. + (max.—min. ·41) = mean temperature].

Spring comprises here the months of				March, April, and May.
Summer	,,	,,	,,	June, July, and August.
Autumn	,,	,,	,,	September, October, and November.
Winter	,,	,,	,,	December, January, and February.

The mean or totals of the year are correct, as given in the Agricultural Statistics, but the means for the four seasons have been calculated from the means of the several months, and they are, therefore, liable to slight corrections; the differences, if any, are, however, small.

38. The wind directions, according to the observations made in 1884, are as follow—if the numbers given for north-west are equally divided between north and west, those given for north-east equally between north and east, and so on :—

West winds, ...	... ...	41 per cent.
South winds, ...	... ...	28 „
East winds, ...	... ...	15 „
North winds, ...	... ...	11 „
Calm, ...	... ...	5 „
	Total, ...	100

39. Dublin is situated on the east coast, and its climate does not represent the average of Ireland. Data, similar to those given above, for a station on the west coast are not at my disposal, but sufficient is known to justify my stating, that the rainfall on the west coast is much heavier than that at Dublin, and, it may be inferred, also the relative humidity of the air.

The following data show the rainfall for a number of stations :—

Cork, annual average of 1860-80,			...	36 inches.
Waterford,	„	„	...	43 „
Kilkenny,	„	„	..	43 „
Armagh,	„	„	...	31 „
Antrim,	„	„	..	35 „

The average rainfall for all Ireland has been calculated to range from 38 to 40 inches a year.

40. Compared with continental European countries of equal latitude, Ireland has a comparatively small range of temperature during the different seasons of the year, a low temperature during summer, a high rainfall, and a damp atmosphere. It follows that the tendency of forests to reduce the temperature, to increase the relative humidity of the air, and also perhaps the rainfall, is not only not required in Ireland, but that it would be actually injurious if it were not very small compared with the action of moist sea winds. In this respect, then, afforestation is not required in Ireland.

3. *Forests in relation to Winds.*

41. The action of forests on winds and the protection which woodlands afford to cattle and useful birds deserve great attention. It is well known that the strong sea breezes which sweep over Ireland, especially along the western coast, impede to a considerable extent the successful prosecution of agricultural operations, and any measure which would reduce this baneful effect must be beneficial. I do not advocate the planting of a *continuous* long belt of forest along the western coast as has been suggested, because such a measure seems to me actually impracticable, and if practicable and carried out, it would protect the fields behind it only for a certain distance, when another belt would be required for the fields further inland and so on. I believe, however, that much good could be done in this respect by a judicious distribution of forest blocks over the country, more especially in the coast districts, without attempting to create continuous belts.

42. The protection which forests afford to cattle is also highly beneficial in a country like Ireland. I have been assured that Scotch farmers pay, in many cases, twice as much for the grazing in forest lands as in open lands; not because the former yield more fodder, but because the cattle thrive better, owing to the protection which the trees afford to them.

4. *Forests in relation to Wood Production.*

43. The question of wood production has been dealt with in the first part of this paper. It is only necessary to repeat here that Ireland is rich in peat, and that coal can be laid down at a low rate; hence the production of firewood is at present of little or no importance. On the other hand, I have attempted to show, that the production of timber is likely to pay fairly by the time forests now planted are ripe for the axe, provided the work is done in a judicious and economic manner.

5. *Forests in relation to Labour.*

44. It has been shown above that forests, if established on surplus lands, bring additional work to the people of a country, not only through their ordinary administration and working, but also by the springing up of a variety of industries connected with forest products. It is evident that the consideration of this question must be of importance to a country like Ireland, where the following remarkable facts face each other:—

On the one hand, Ireland has large areas of waste land, which could easily be converted into useful cultivated tracts;

On the other hand, the population of Ireland has steadily decreased during the last 40 years, chiefly by emigration, in round figures from eight to five millions; even now emigration continues; a certain number of agricultural labourers seek, during part of each year, work elsewhere; and generally a good deal of poverty prevails, especially in the coast districts.

What is the cause of this? Here is a problem which has *been, for years past, one of strong contention in political circles.* It is not my intention, nor have I any desire, to discuss the Irish question generally, but, in order to deal with afforestation in relation to labour, I am constrained to offer a few remarks on it, with due deference to those who are better qualified to judge.

45. It has been said, that the Irish rural population is lazily inclined; but it is also well known, that the Irishman is a first-class workman, when employed elsewhere. Why should he work hard in England, and why not in Ireland? Surely only for this reason, that it pays him to do so in the one case, and not in the other. Emigration has, even of late, been encouraged. To get rid of a number of troublesome people may be

very convenient for the moment, but such a measure cannot produce any lasting good effect; to establish peace in a country by depopulating it is, of course, opposed to all sound principles of national economy. As long as waste lands fit for cultivation are available in a country, emigration should be discouraged and not encouraged. The cause of the evil must be looked for elsewhere, and the cure attempted by other means. It cannot, for a moment, be supposed that Providence made the Irishman essentially different from those around him; there must be some cause inherent to the country in which he lives, which has by slow degrees, made him what he now is. This I believe to be the peculiar climate of the country combined with the state of proprietorship of the land. Nature has produced the former, the act of man the latter.

46. According to the present state of affairs, the ordinary Irish cultivator is expected to earn a livelihood for himself and his family, and to pay rent to the proprietor of the land. If the climate of the country was more favourable for agricultural pursuits, than it is, the cultivator might be able to meet both demands permanently; in reality, and especially in the poorer parts of the country, he gets on fairly well in good times, but he breaks more or less down in unfavourable times, because the surplus earnings of good years are not sufficient to carry him safely over bad times. In other words, the climate of a great portion of Ireland is not sufficiently favourable to produce crops, which will permanently support the tenant and yield large rents to the proprietors of the soil. The consequence is that the tenant, not having sufficient interest in his holding and consequently in the peace of the country, is easily persuaded to agitate, and the proprietor must forego his rents in a greater or less degree. Could the cultivator *by fair means*, be converted into the owner of the land, his means would be greater by the amount of rent now paid, and he could live with his family and be in a better position to weather unfavourable years. Above all, he would have a substantial interest in the peace and quietness of the country, and he would soon learn to turn a deaf ear to the words of the agitator.

47. The Legislature of this country has clearly expressed the intention of assisting the Irish tenants to become the owners of the soil, which they cultivate. The last Land Law (Ireland) Act of 1881, contains provisions to regulate the rents chargeable on land, and to facilitate the purchase by the tenants of their holdings under certain circumstances and conditions. Section 26 of that Act empowers the Irish Land Commission to purchase any estate for the purpose of re-selling to the tenants comprised in such estate their respective holdings, if the Land Commission is satisfied with the expediency of the purchase, and is further satisfied that a body of tenants not less than three-fourths of the total number, and who pay in rent not less

than two-thirds of the whole rent of the estate, are able and willing to purchase their holdings. The condition as to three-fourths of the number of tenants may be relaxed on special grounds, with the consent of the Lords Commissioners of the Treasury, but in no case shall the number of tenants, who are able and willing to purchase, be less than one-half of the total number. The Act provides further, that the Land Commission may sell any parcels of a purchased estate, which it does not sell to the tenants thereof, in such manner as it thinks fit; the Land Commission may also advance up to three-fourths of the purchase money to any tenant who buys his holding, the sum thus advanced being recovered in instalments.

48. I understand that, although many proprietors would be only too willing to sell their estates, little advantage has, up to date, been taken of the facilities offered to the tenants to become the proprietors of their holdings. This is, no doubt, to a considerable extent due to the acute agitation at present prevailing in Ireland, but partly also to the difficulty of disposing of whole estates. A few tenants may offer to buy their holdings, but the proprietor naturally hesitates to dispose of these, perhaps the best, holdings, and have the rest, in a cut-up condition, left on his hands. Again, the Land Commission cannot act unless three-fourths, and under special circumstances one-half, of the total number of tenants are able and willing to buy their holdings. This limitation was, apparently, inserted in the Act, because the Legislature did not wish to encumber the Executive Government with extensive areas which might be left on its hands, and from which no suitable returns could be obtained. It is here, that afforestation may become an useful auxiliary in solving the Irish land question, especially in the poorer parts of the country. Assuming that more extended powers were given to the Land Commission, and it bought a large estate, say in Connemara or Mayo, it would proceed to sell to the tenants as many of their holdings as they were able and willing to purchase, and perhaps sell additional parcels to outsiders. This operation should be conducted on the principal of "give and take," and suitable compensation, if necessary, given for rights in outlying parts, so as to round off the area disposed of. Of the remaining lands some may consist of holdings, the tenants of which are neither willing to purchase, nor would it be advisable to evict them, and they would have to be kept for a time, as Government tenants, until they became able and willing to acquire their holdings, or give them up; but if the proceedings are conducted on the right lines, it will doubtless be possible to reduce their number to a minimum. All lands then left in the hands of the Land Commission, which would be principally situated on the hill ranges, should, in my opinion, be converted into State forests, as far as they are fit for the purpose. The surplus lands would represent only a comparatively small portion

of the purchase money, as they would comprise the less valuable parts of the estate. In this manner Government would be able to utilize all surplus lands in an economic manner.

49. It has been said above, that agriculture in Ireland does not yield returns sufficiently large to enable the cultivator to live and to pay rent permanently, and now it is proposed that he shall, over and above, purchase his holding. The task is of course beset by great difficulties, but I believe that it can be accomplished, if the State recovers the purchase money under the system of a sinking fund, calculating the annual payments with the rate of interest at which the State can borrow money, and if, in the poorer districts some additional work can be provided, which enables the new small proprietor to earn something in his spare time. If the State is determined to take steps which will go at the root of the Irish difficulty, and effectually interfere in the land question in the manner indicated above, the result would be, that the annual payment, under the system of a Government sinking fund, to be made by the cultivator, would little, or not at all, exceed the rent which he has now to pay, owing to the low interest at which Government can borrow; the cultivator would not be worse off than hitherto, and after a series of years his payments to Government would cease altogether. In order to pilot him safely over the transition period, additional work is required, and this must be of such a nature that it will fit in with agricultural requirements. Ordinary industries will, as a rule, not do this, because they produce a separate class of workmen, who devote themselves to the special work. Afforestation of the surplus lands, on the other hand, will be found to suit the case. Every acre of land planted with forest will involve an outlay of £2 to £3 in wages, which can be earned by the surrounding population; and after the forests have been created, work connected with their management and forest industries will replace that provided by the original planting. Excepting the duties performed by the administrative staff, the work connected with forest operations can be done when agricultural operations are slack, and the small cultivator can take advantage of every spare day to earn a day's wages by work in the forest, or devoting it to simple forest industries, and thus increase his income and capability of meeting the annual payment when it becomes due. The labourer can in most cases live in his own home, and he can put by the whole of the extra earnings; this is of great importance, for if he had to go to some distance for extra work, he would have to spend a great part of his earnings before he returned home. I believe that, as regards the solving of the Irish land question, and through it the ultimate restoration of peace and quietness in the country, the afforestation of surplus lands, especially in the coast districts, will be found of considerable importance.

50. Dr. Lyons, Sir Thomas M'Clure, and Mr. Maurice Brooks prepared and brought into the House of Commons in 1884, a Bill for the re-afforestation of the waste lands of Ireland, in which it is proposed to accomplish the work through the agency of occupiers of waste lands, tenants of land for statutory terms, owners, Boards of Guardians, and Government. This is as it should be; but the returns from newly planted lands are so distant, and the plantations have to be closed against grazing for such a long period, that tenants are not likely to render much assistance. More may be done by proprietors, though many will be unwilling to invest further funds in Ireland, and others may be unable to do so. Something will probably be done by Boards of Guardians, but in many cases, I feel satisfied, Government will have to take the initiative. Objections might be raised to Government becoming in this way the proprietor of extensive lands, but I do not propose that it should interfere, except in those cases in which present proprietors are unwilling or unable to keep the matter in their own hands. At any rate Ireland has now drifted into such a condition that some sacrifice must be made. Much weight has also been attached to the springing up of forest industries; these are not likely to be created unless the supply of the necessary forest produce is regular and sustained. There is no guarantee that this will be the case as long as the woodlands are all held by tenants and private owners; for this reason it is necessary that at any rate a portion of the forest area should be under the permanent control of Government.

6. *Area available for Forests in Ireland.*

51. In the first part of this paper I have given the general distribution of the land in Ireland; it will be useful to add here a somewhat more detailed record of it. The Agricultural Statistics of Ireland for 1884 give the area of waste lands as follows:—

	Statute acres.
Bog and Marsh, ...	1,738,751
Barren Mountain Land, ...	2,164,403
Water, Roads, Fences, &c., ...	8,50,332
	4,753,486

This total does not include an area of 494,726 acres under the larger rivers, lakes, and tideways. The area of 850,332 acres under water, roads, and fences, &c., may be at once left out of consideration; there remain then 3,903,154 acres. Assuming that one-half of this area is fit and available for planting, an area of 2,000,000 acres in round figures (= 3,125 square miles), could be converted into forests. The above areas are distributed amongst the several counties in the following manner:—

County.	Bog, Marsh, and Mountain Land.		Percentage of Grass Lands to total Area.	Percentage of Land under Crops to total Area.
	In Statute Acres.	In per cent. of the Total Area.		
Donegal, ...	508,502	43	33	18
Mayo, ...	545,915	41	40	13
Kerry, ...	381,694	33	49	13
Galway, ...	459,897	31	50	13
Sligo, ...	109,030	24	51	19
King's, ...	117,664	24	47	23
Tyrone,...	183,637	24	42	30
Wicklow, ...	117,955	24	49	21
Waterford, ...	97,574	21	52	18
Cork, ...	334,418	18	54	22
Londonderry, ...	90,872	18	42	35
Leitrim, ...	60,992	16	54	23
Longford, ...	40,896	16	52	26
Roscommon, ...	86,330	15	59	22
Clare, ...	109,102	14	61	19
Antrim, ...	83,931	12	51	32
Tipperary, ...	120,354	12	58	25
Queen's, ...	46,724	11	53	30
Fermanagh, ...	44,822	11	59	23
Kildare, ...	39,651	9	59	26
Westmeath, ...	40,989	9	64	20
Down, ...	51,158	8	39	46
Cavan, ...	37,425	8	54	30
Louth, ...	15,179	7	39	46
Carlow, ...	15,708	7	54	34
Limerick, ...	46,363	7	62	26
Wexford, ...	35,280	6	53	35
Dublin,...	13,493	6	50	35
Kilkenny, ...	26,802	5	59	28
Armagh, ...	15,739	5	40	49
Monaghan, ...	13,583	4	48	40
Meath, ...	11,475	2	70	22
Total of all Ireland, ...	3,903,154	19	51	24

52. In the above table the counties have been arranged according to the proportion of waste land to the total area. It would be beyond the scope of this paper to examine in detail the points on which afforestation depends, nor would it be possible to do so without a minute examination of each locality, but, in a general way, it may be said to be governed by the extent of waste land and its proportion to the total area. The proportion of land under crops to the area of grass land is also of considerable importance. Donegal, Mayo, Kerry and Galway head the list just given, their percentage of waste land ranging from 43

to 31. The proportion of land under crops to grass land in all Ireland is 24 : 51, or about 1 : 2 ; in the above four counties it is as follows:—

In Donegal,	...	...	...	18 : 33
,, Mayo,	...	...	...	13 : 40
,, Kerry,	...	...	...	13 : 49
,, Galway,	...	...	...	13 : 50
	On the whole about		...	14 : 43=1 : 3

Under these circumstances it may be assumed that the greater portion of the waste land in these counties, amounting to 1,896,008 acres, could at once be made available for afforestation. At any rate, I feel sure to be within the mark by counting on 1,000,000 acres, or scarcely more than one-half of the total waste area, which would be distributed somewhat in the following way :—

				Statute Acres.
In Donegal,	...	...	...	250,000
,, Mayo,	...	...	...	300,000
,, Kerry,	...	...	...	200,000
,, Galway,	...	...	...	250,000
		Total,	...	1,000,000

Sligo is likely to provide 50,000 and Cork 150,000 acres, while the remaining twenty-six counties would be able to contribute the remaining 800,000 acres of the total estimated area of 2,000,000 acres, without trenching to an appreciable extent on the fodder resources of the country. The afforestation could only be carried out by degrees, and the areas would not be closed against grazing until they are actually taken in hand. After the forests have been created, only about one-third of their area need be closed at one time, the other two-thirds being available for grazing. Here, then, is a field for action, whether it be undertaken by Government, corporations, proprietors, or tenants. The returns which the waste lands yield in their present condition are, on the whole, small, and afforestation could, I have no doubt, be made to pay fairly, apart from the benefit which the people in the poorer coast districts would derive from the increase of work afforded near their homes, and the protection which the forests would give to the adjoining fields and to cattle.

7. *Organization.*

53. If it should be decided to carry on afforestation in Ireland on an extensive scale, it will be necessary to provide a central authority, which can direct the operations on the right lines. The Bill for the "Re-afforestation of the Waste Lands of Ireland," mentioned in paragraph 50, proposes the following organization :—

(1). A fit and proper person, eminent for his knowledge and skill in the science and practice of forestry, shall be appointed to be Chief Forest Conservator for Ireland.

(2). Five persons shall be appointed to be Commissioners of Forestry for Ireland, of whom one shall be the Chief Commissioner of Works for Ireland for the time being, one shall be the Vice-President of the Local Government Board, one shall be the aforesaid Chief Forest Conservator for Ireland, and two shall be such persons, one eminent in the law and one eminent for his knowledge of forestry, as the Lord Lieutenant shall select and appoint, and who shall be willing to act as unpaid Commissioners. These five Commissioners shall constitute the Forest Department of Ireland.

(3). The Forest Department of Ireland, as constituted above may, with the consent of the Treasury, appoint a Secretary, and such Assistant Forest Conservators, Inspectors and other necessary Officers, as the Treasury shall sanction.

54. The principal duties of the Irish Forest Department are described in the Bill as follow :—

(*a*). The Forest Department may acquire by purchase, or rent for terms of years, suitable lands for forest purposes, wherever forests may be required for shade or shelter, as wind-brakes, for the protection of agricultural land, for the control or regulation of the water supply, for the preservation of the soil, for the remedy of floods and torrents, or for the improvement of any other of the physical conditions subservient to animal or vegetable life.

(*b*). The Forest Department may, in the same way, acquire suitable lands with the view of increasing the forest area of Ireland generally up to one-fourth or one-third of the total area, and constitute such lands State forests of Ireland.

(*c*). The Forest Department may accept the temporary assignment of waste lands for the purpose of re-afforesting them, or it may undertake the care, management, and felling of any forests growing on lands so assigned to it, or the care, direction, and management of any existing forests in Ireland.

(*d*). Wherever floods and torrents prevail in Ireland, the Forest Department may institute an inquiry by competent Officers into the nature, origin, and extent of such floods and torrents, and prepare a scheme for the effectual remedy of the same. The proprietors and occupiers of such a flood district

may be summoned together by the Forest Department, to constitute themselves into a syndicate for the purpose of carrying out the scheme proposed by the Forest Department. On the neglect or refusal of the proprietors and occupiers to constitute such a syndicate within twelve months, the Forest Department may apply for an order to the Local Government Board to enter on the said lands, and carry out the necessary operations at the expense of the proprietors and occupiers of the lands.

(*e*). The Forest Department shall furnish any Board of Guardians in Ireland, carrying out re-afforestation operations, with a detailed scheme for the planting operations most suitable to the locality to be planted, and depute an officer from time to time to inspect and report on such works.

(*f*). The Forest Department may establish a School of Forestry for Ireland, conduct examinations in forestry, and confer diplomas in forestry.

55. These provisions cover the principal ground. What final shape the organization would have to take depends on the results of Irish legislation, which, I understand, is now pending. There will, under any circumstances, be a central authority in Dublin, to which a Commissioner for Forests could be attached. The Commissioner must, of course, be a person eminent in the science and practice of forestry, and he should be a member of a Board constituted on the lines given in the above mentioned Bill. That Board would be the Forest Department of Ireland. As regards the subordinate staff it is, at present, only necessary to say that the members must be carefully selected, so as to insure success at the start. Probably operations would be commenced in one or two localities only, and they would afford opportunity for training a number of young Irishmen, who could then be drafted to commence work in other localities.

8. *A few Sylvicultural Notes.*

56. The methods, according to which afforestation shall be carried out, and the species of trees to be planted must be determined and selected by the professional staff with special reference to the conditions of each place. I found everywhere evidence, not only of forests which grew in Ireland in former times and the remnants of which can still be seen in the peat bogs, but also that forests can be grown and will thrive in the present day. Even in the immediate vicinity of the west coast I saw well grown woods. Solitary trees are, when exposed to strong winds, much deformed, but wherever they are grown in masses and the ground is well stocked, only those directly exposed to the wind

are injured in their growth, while they afford the necessary protection to those standing behind them. The depth of the injured belt differs according to the force of the wind and the general exposure of the locality, but, under proper treatment, it need not be very great, and the loss of growth on this account would not be serious.

57. As regards the species of trees to be grown, I desire to add a word of warning. I have seen long lists of exotic trees, which are recommended for planting in Ireland. If anything of this kind were attempted at the outset, it would be sure to bring discredit on the operations, and I feel satisfied, that no forester of experience would countenance any such steps. The main stay of the operations for years to come must be the species, of which it is known that they will thrive and produce good serviceable timber in Ireland. After the business has been got into working order, there would be no objection to experiments, on a small scale, with exotic species which promise well, but I should deprecate any large expenditure under this head, until experience has proved that a species is suited to the climate of Ireland.

58. Of the indigenous and well established species, the Scotch fir will be the ruling tree in the dryer localities, and spruce in the moister places. Alder may be planted in wet situations, in so far as they cannot be used for osier beds. Oak and silver fir may be grown in suitable localities and soils. Larch will, on account of its quick growth and superior timber, deserve attention, provided it is mixed with other suitable trees in a proportion ordinarily not exceeding one in four. Birch will come in useful in many exposed localities, especially in protecting belts. Sycamore and other useful trees may be sprinkled into the forest in suitable localities. Beech is an exceedingly useful tree from a sylvicultural point of view, but it yields chiefly firewood; nevertheless, its cultivation should not be lost sight of, especially as some of the forest industries depend on the supply of beech wood.

More I do not desire to say at present under this head.

Before bringing this paper to a conclusion, I desire to repeat that it makes no pretension at being exhaustive. Still, it may be found to contain some remarks which will be useful in considering and solving an economic question of some importance to Great Britain and Ireland, and more especially to the latter country.

W. SCHLICH.

London: 1st January, 1886.

SALES AND EXPORT OF TIMBER IN FRANCE.

With the exception of produce made over to the right-holders, and of comparatively small quantities of timber cut for the War

Department and Admiralty, the whole of the annual produce of the forests, whether State or Communal, administered directly by the French Forest Department, is sold by public auction, and no other mode of sale is permitted.

There are three principal systems of disposal, *viz.*, 1*st*, sale of standing trees ; 2*nd*, sale at a rate per cubic metre, or other unit of the produce cut, fashioned and taken out by the purchaser ; and 3*rd*, sale of produce cut and fashioned by Departmental Agency. The first of these systems is that which is much the most generally employed. It necessitates a previous marking either of the trees which are to be removed or of those which are to be reserved ; there is no guarantee given as to the number of trees sold, their species, cubic content, age or condition, but they are sold and bought on the best estimate that either party can make of their value as they stand. The purchaser cuts up and exports the wood at his own cost, and in the form which best suits him. Two objections to this method of disposing of the produce have been raised, *viz.*, that a middleman is needlessly introduced between the producer and the consumer, and that the regeneration of the forest may be compromised by the felling and exporting of the trees in a careless or ignorant manner ; but in reply it is said that the wood merchant must always exist, as it is but rarely that the actual consumer can go direct to the forest to get what he wants, and in practice it is found that by strictly enforcing the conditions of sale the regeneration of the forest is in no way interfered with. The second method differs from the first only in that the auction sale determines merely the *rate* at which each of the various classes of produce is to be paid for, and as soon as the felling and conversion is completely finished, the merchandize is counted and paid for at those rates. This system is sometimes employed for wood of small dimensions such as thinnings, when the quantity to be sold cannot well be estimated beforehand ; but it has this drawback, that it often gives rise to disputes regarding the classification of the produce, and it is to be feared that in settling them the interests of the State are sometimes allowed to suffer. The sale of timber cut and fashioned by Departmental Agency is rarely resorted to ; it has certainly the advantage that the work is better done, and that more complete precautions are taken to secure the regeneration of the forest ; but on the other hand the State is obliged to advance all the money for the work, and the Forest officers are charged with a large amount of supervision and of accounts, while a number of purchasers are admitted to the forests, and offences of various kinds are committed by them ; but the chief objection to the system is that the wood is not always cut up in the manner which best suits the requirements of the market at the moment, a matter with which the Forest officers can never be so well acquainted as the professional timber merchants ; and

thus not only do the general interests of the country suffer, but the prices obtained are not always the best that the produce might be made to fetch if cut up in some other manner. Higher rates are usually paid for timber sold standing than when it is sold in any other way, and as this is the system of sale generally adopted both in the State and in the Communal forests of France, some details as to the conditions under which the auctions are conducted, and under which the timber is cut up and exported, will now be given. It should, however, be stated that the practice of selling trees in this manner is not generally followed in other European countries ; but the French system has stood the test of experience, and it is greatly facilitated by the honesty which, as a general rule, prevails in the trade to which it has given rise.

Sales.—The portion of forest on which the timber is to be sold is demarcated and mapped, and the trees (either those to be sold or those to be reserved, as the case may be) are marked by at least two Forest officers acting together, and assisted by the Forest guard in whose beat the sale is to take place. The sale is then duly advertized, and the following documents are deposited at the office of the Civil officer, usually the *Préfet* or the *Sous-Préfet*, who is to preside at the sale—

1st. A written statement showing the measurement of the ground and the number of trees of each class that have been marked to be reserved.

2nd. A copy of the conditions of sale as sanctioned for general use, and of such special conditions as may have been introduced by the Conservator.

The *Maire* can preside at the sale when the produce to be sold is valued at not more than £20. The Conservator is usually present, as well as the local Forest officers. The sale is carried on *au rabais*, under which system the Conservator determines the upset price, which is always somewhat above the estimated market value of the produce, and the auctioneer then proceeds to cry down a gradually diminishing scale until some one cries *je prends*, when the merchandize is knocked down to him. The successive diminutions in the price named by the auctioneer are fixed beforehand. This system is devised to prevent as far as possible combinations to reduce the purchase price, such illegal combinations being severely punishable. Immediately after the sale the purchaser must satisfy the presiding officer regarding his solvency, and his ability to produce sufficient securities, in default of which the produce is at once put up again for sale at his risk and cost. As soon as the sale is completed, the conditions are signed by all the officials present and by the purchaser, who has to defray all the costs of the sale. Within five days of the date of the auction the security must be accepted and completed, and within the succeeding five days the purchaser must provide for the payment of the purchase money by

means of four drafts, each for one-fourth of the sum due, and one of which is presentable at the end of each quarter, or he may pay the whole sum down, receiving a discount on it. In case of failure to comply with any of these conditions the lot is re-sold at the cost and risk of the first purchaser, who is responsible for any diminution of price that may result therefrom.

Felling and working out the timber.—The principal conditions relating to the felling and working out of the timber are the following, *viz.*, no change can be made in the position or constitution of the lot after it has been bought; the purchaser cannot commence work until he has been formally placed in possession by a written order, which is accompanied by a plan of the ground and a copy of the conditions of sale; he must warn the Forest officer of the date on which he proposes to commence work; he must appoint a factor or guard, approved by the Forest officer, and sworn before a Magistrate; the purchaser must register his timber mark; he must respect all trees marked as reserved, and is responsible for damage done to any of them; he cannot carry on any work in the forest between sunset and sunrise; he must not peel or bark any tree until after it has been felled; he must not burn charcoal except in places sanctioned in writing by the Forest officer; he must not drag wood out of the forest by any but authorized roads; his work must be finished within the time specified in the conditions of sale, unless an extension of that time has been obtained; such an extension can only be granted by the Conservator on condition that the purchaser makes good any loss that the Department may suffer in consequence, but unless the delay in the completion of the work proceeds from unavoidable causes, the purchaser is not thereby exempted from the payment of the penalties he has incurred by his non-fulfilment of the conditions of sale; before the ground is quitted by the purchaser he may be called upon to clear it of thorns and brambles and of certain kinds of shrubs, while the roads, ditches, bridges, pillars and walls must always be repaired, all charcoal burning and building sites being dug over; fires must not be lighted outside the workmen's huts; no wood from elsewhere can be introduced into the purchaser's wood sales. The purchaser can demand an examination of the ground for the purpose of recording any offences that may have been committed on it before he is put in possession.

The sales usually take place in September; as a general rule the trees must be all felled before the 15th April following, and the wood must all be taken out within twelve months of the latter date. The mode in which the trees are to be felled, the stumps to be cut and the produce worked out, as well as that in which the ground is to be cleaned, is fixed by special clauses in the conditions of sale. No animals can be taken into the forest unless they are muzzled. For the infraction of the above and any other of the conditions of sale a penalty is imposed.

The purchaser is responsible, from the date on which he is given permission to commence work until that on which he receives his discharge, for all forest offences, not reported by his guard, which may have been committed not only within the area over which he has purchased the right of felling, but also within 250 yards of that area in every direction, and he and his securities are personally responsible for the payment of all fines and other penalties inflicted for offences committed by his factor, work-people, wood-cutters, cartmen and others.

Re-survey and verification of the work.—Within three months of the expiry of the term granted for the export of the wood, the ground must be examined in order to see that the conditions of sale have been fulfilled, the principal point being of course that none of the reserved trees shall have been touched. The verification is effected by at least two Forest officers and the Forest guard, the purchaser having the right to be present himself or to send his representative. If within one month no appeal is made against the report of these officers either by the Forest Department or the purchaser, the Prêfet, acting with the consent of the Conservator, gives the purchaser his discharge.

F. B.

LIGHT GRAZING.

REFERRING to "J. C. McD's." and "Konda Dora's" remarks on my notes on "light grazing," I have now to add that I should have qualified my letter by saying that it related to deciduous forests in Southern and Central India.

After 10 to 15 years of protection from fire the grass is found to grow as abundantly as ever. I allude to reserves aggregating over 100 square miles. This season the grass has been so plentiful that a casual observer would never know that these forests had *not* been burnt for many years, so completely has the new crop of grass over-grown and concealed that of former years. From this experience one may safely argue that fire-protection of itself will not appreciably diminish the growth of *grass*.

The greater area of these reserves is not capable of being brought under cultivation, and have never been under temporary cultivation even of "dhiya"; and with few exceptions the trees are of those species which are naturally propagated from shoots and suckings.

"Light grazing" may be defined as weeding the forest of grass by grazing to such an extent that the grass is kept under a foot in height or thereabouts. I know scores of square miles of unprotected forests where the grazing answers this description, and where consequently reproduction is very promising. In the open glades the grass does not grow in such profusion as to en-

tirely smother all seedlings, and in among the trees the grass is kept down sufficiently as to check the evil results of fires.

With respect to "reproduction." These unprotected (from fire) forests, where the grazing is light, compare favourably with the fire-protected areas where grazing is prohibited. For the latter are handicapped by the excessive injury caused by fires which occur in most of them, say once in ten years; also by the fact that "protection from fire" has not the desired effect of diminishing the growth of grass, and thereby seedlings have no chance of making head-way. There is another consideration also to be taken into account as regards this class of reserves, *viz.*, since timber and all other cutting are now carried on by private agency, it is necessary to close these areas for about one-third of the year, when the entire time and attention of the ordiary and an extra establishment are taken up with fire-protective measures.

I hold to the opinion,—which I believe is backed up by the experience gained during the past 15 years,—that under ordinary circumstances and at proper seasons the prohibition of grazing in the fire-protected forests is a mistake, and that "light grazing" would be beneficial and advantageous.

A. J. C.

27th February, 1886.

CREEPERS.*

It has been observed in certain forests which have been protected from fire and grazing for many years that the increase in the growth and spread of creepers (the *Bauhinia*) has been *immense;* to such an extent has this taken place in a few large areas, that at a rough survey one would think every third or fourth tree was being strangled. What can have caused this great increase? Can it be due to protection from fire and the resultant luxuriant undergrowth of grass, &c.? Whatever may be the cause this is certain, that no where in the unprotected forests is this creeper found at all so plentiful, but rather their growth is exceptional in the latter class of forests.

A Conservator in his last year's annual report gives as his opinion that the creeper pest comes next to that of fires and grazing.

Would some of your readers who have experience in the deciduous forests of Central and Southern India give the result of their observations on this important subject.

* We prefer the term *Climber*, as more general than that of *creeper*, which is suitable to the ivy and creeping fig and other plants lacking rigidity when unsupported by a tree or shrub. Climbers, such as the *Millettia auriculata* and *Bauhinia Vahlii* have considerable rigidity of stem, and the former assumes an arborescent form if it remains growing for several years without securing support.—[ED.]

In the forests to which I allude attempts are made each year to eradicate this evil, but hitherto without success. The coppicing of this creeper has had the effect of multiplying them. Then how is the spread of this pest to be checked in fire-protected forests (where grazing is also prohibited)? A vital forest principle is at stake in the settlement of this question, namely, "the preservation of trees and the production of timber."

2nd March, 1886. A. J. C.

GRAZING IN THE FRENCH FORESTS.

I FIND that I fell into an error when writing the paragraph of my article on the above subject which appears in the Number for June 1885, at the bottom of page 262. That paragraph should stand thus—

"Goats are not admitted into any forest which is under the *régime forestier, as the grazing of these animals is considered* incompatible with the maintenance of the ground under wood. The old laws suppressed, without compensation to the right-holder, the grazing of sheep in the forests of the ancient royal domains of France, and the law of 1827 (above quoted) suppressed it also, but on payment of compensation, in those State forests which are of more recent origin. The law also prohibits, as a general rule, the grazing in the Communal forests of both goats and sheep belonging to the inhabitants of the Communes. But the Government has the power, to permit sheep grazing both in the State and in the Communal forests in certain localities and as an exceptional and temporary measure. Permission to drive sheep into the State forests is very rarely accorded, but it is not yet found possible to suppress the practice in the Communal forests, and sanction to graze sheep in them for periods of from one to five years is still granted to the inhabitants in a considerable number of cases."

F. B.

FOREST ORGANIZATION FOR BEGINNERS.

ALLOW me to point out a small error in the paper on "Forest Organization for Beginners" in the February Number of the "Indian Forester." It is stated at page 53 that "the average co-efficient (f) will then be represented by a fraction which has for its numerator the contents of the group (c), and for its denominator, the sum of the heights of all trees (L) multiplied by the sum of their basal areas at $4\frac{1}{2}$ feet from the ground (A). The formula for this operation would, therefore, be $f = \frac{c}{A \times L}$."

It will not take much to see that the average coefficient (why discard the well known "reducing-factor"?) will be represented

by a fraction which has for its numerator the contents of the group (c), and for its denominator, the product of the *average* height of the trees (l) by the sum of their basal areas at $4\frac{1}{2}$ feet from the ground (A), or, which comes to the same thing, for the denominator, the product of the sum of the heights of all trees (L) by the *average* basal area at $4\frac{1}{2}$ feet from the ground (a); the formula being

$$f = \frac{c}{A \times l} \text{ or } \frac{c}{a \times L}, \text{ that is } \frac{c}{(A \times L)\frac{1}{n}}.$$

C.

THE SPARROW.

The following strange behaviour of a sparrow may perhaps be thought worthy of record, and it would be interesting to know if any of your readers have observed a similar occurrence.

I was sitting in my tent a few days ago, when I saw a cock sparrow fly in, and perch himself on a table in front of a looking glass. He seemed perfectly fascinated by his reflection there, and put himself in every imaginable position, at first slightly pecking at the mirror, but afterwards calming down, and steadily gazing. He remained there till evening, when he flew away, but early next morning returned, and took up the same position, only going away for his food, and this he has repeated some days in succession.

I have seen a sparrow fight its own image in a looking glass for hours together, but I have never seen one apparently admiring itself as this one did. Could it be he was in search of a mate, and thought he had here found a possible one?

G. F. S.

A PLANT RICH IN TANNIN: *CASSIA AURICULATA.*

This plant is very common in Ceylon, being found all over the low country and plentiful along the east coast. It is very easily cultivated and will grow in any soil. The tannin qualities of its bark are well-known in the English market, being largely exported from India and some from Ceylon. It is a shrub that springs up freely when coppiced and a profitable crop cut every second or third year. Round the Northern and Eastern coasts it is annually collected by the Moor traders, and I have seen gangs at work in the forests peeling the bark and carrying it off to Trincomalee. "This shows another of our forest products pilfered through the laxity and want of proper forest administration." The shrewd Moor trader of Colombo has his agents everywhere and gives from Rs. 4 to Rs. 7 per cwt. dry bark delivered in Colombo.

You will find Cassia bark quoted in the London market at Rs. 12 per cwt.—J. A.—*Tropical Agriculturist.*

IV. Notes, Queries and Extracts.

Mahwa Flowers.—Attention has been publicly drawn of late to "Mahwa Flowers"—the corollas of *Bassia latifolia*—as a cheap source of cane-sugar. This species of Bassia is a tree attaining to a height of 40 to 60 feet, and common in many parts of India, especially in Central Hindustan. It has oblong leaves of firm texture, from 5 to 6 inches long; these fall in February, March, or April, and are succeeded in March or April by the flowers. These last for two or three weeks and then begin to fall. The falls take place at night, and continue sometimes for a fortnight. The fruits, which resemble a small apple, ripen in three months; the seeds, one to four in number, yield an edible oil by pressure. It should be added that the trees are self-sown, and that they flourish in very poor and stony soil.

When the Mahwa tree is in bud, the ground beneath it is cleared of weeds, sometimes by burning. A single tree may yield as much as six to eight maunds* of flowers; even 30 maunds have been asserted to have been collected from one tree. These flowers have a luscious but peculiar taste when fresh; when dry they resemble in flavour inferior figs. They form a very important addition to the food of the poorer classes in those districts where the tree abounds, particularly in the neighbourhood of woodlands and jungles. They are especially useful in economising cereals in seasons of famine and drought. They are sometimes eaten fresh, but more commonly sundried, and are usually consumed with rice and the lesser millets, or with seeds of various kinds, and leaves. It is said that a man, his wife, and three children may be supported for one month on two maunds of Mahwa flowers.†

It is not, however, as a direct article of food, nor as a material for the preparation of a rough spirit by fermentation (a very common use of these flowers) that Mahwa blossoms are now recommended. It has been affirmed that they may be employed as an abundant and very cheap source of cane-sugar. In the *Morning Post* of October 15th, 1885, appeared an article on this subject, in which it was stated that: "If the Mahwa flowers be available in sufficient quantities for the sugar-makers of Europe, there can be no question that the days of the beetroot are over, and sugar-cane will go the way of all discarded

* A Bengal maund equals 82¼ lbs. avoirdupois.

† For an interesting account of the Mahwa tree and its products, see a paper by E. Lockwood in the *Journal* of the Linnean Society ("Botany"), Vol. xvii., pp. 87-90.

products." This prediction depends, however, upon another condition besides that of the abundance of the flowers. If the sugar they contain be wholly or chiefly cane-sugar, that is, "sucrose," then the argument is not without weight. But the nature of the saccharine matter of the Mahwa does not appear to have been ascertained. MM. Riche and Rémont (*Journ. de Pharm. et Chimie*, 1880, p. 215) stated that the air-dried flowers contain 60 per cent. of fermentable sugar, of which about one-seventh is crystallisable. The material available for analysis in Europe consists, of course, of the dried flowers. These may have suffered some change beyond the mere loss of water, but the evidence they afford on chemical examination is not favourable to the view that they are likely to compete with sugar-beet or sugar-cane as a source of cane-sugar. Here is the result of an analysis of a sample of Mahwa flowers (from the Kew Museum) in their air-dried condition :—

	In 100 parts.
Cane-sugar, ...	3·2
Invert-sugar, ...	52·6
Other matters soluble in water, ...	7·2
Cellulose, ...	2·4
Albuminoids, ...	2·2
Ash, ...	4·8
Water lost at 100° C., ...	15·0
Undetermined, ...	12·6

The flowers analysed had a slight smell of fermented saccharine matter and a distinct acid reaction. But it is not at all probable that they could have contained any large proportion of cane-sugar even when quite fresh, and that 15-16ths of that sugar had been inverted during the process of desiccation. We cannot argue from analogy in this case. For while the nectar of many flowers contains no sugar except sucrose, invert-sugar occurs in some blossoms, as well as in many other parts of plants. Even the unripe and growing stems of the sugar-cane and of many grasses contain much invert-sugar. It must, however, on the other hand, be remembered that cut sugar-canes imported into this country contain a large amount of invert-sugar, and that if they be kept a week only after the harvest the invert-sugar naturally present in the juice shows a marked increase and the cane-sugar a corresponding diminution. On the whole, then, so far as the materials at my disposal enable me to judge, I believe that the saccharine matter of fresh Mahwa flowers will be found to consist mainly of dextrose and levulose, and that consequently they will not be available as a material for the economic production of sucrose.

I have to thank Mr. W. T. Thiselton Dyer, C.M.G., Director of the Royal Gardens, Kew, for drawing my attention to this subject, and for a supply of the material on which I have worked.—A. H. Church.—*Nature.*

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FOREST ORGANIZATION FOR BEGINNERS.

(*Continued from page 99*).

SECTION III—ASSESSMENT—(*continued*).

CHOICE OF A METHOD OF ESTIMATING THE CONTENTS OF GROUPS.

This depends on the value of the forest, the description of the group to be examined, the nature and strength of the staff available, and the system it is intended to adopt for determining the annual yield of the forest.

It is now very generally admitted that great accuracy is seldom necessary except when estimating the contents of the oldest trees, and others, which will probably be cut down during the current period (*i.e.*, the next 10–20 years).

For irregular, but valuable, seedling-forests treated by the method of regular cuttings, (*see* page 3,) it will generally be advisable to adopt for the oldest groups one of the systems which require the felling of test-trees and the diameter-measurement of all trees, together with separate height-classes. But, if a group be of relatively small value, or fairly regular as regards height and density, less laborious means may be employed : height-classes may be dispensed with, and the method of test-plots, combined with the felling of test-trees, or without fellings by means of form-coëfficients, if tables of the latter are available, may be adopted. Younger groups may be assessed according to their densities and quality-classes by means of experiential tables, or according to the known yield of similar groups in the vicinity, or they may be left out of the reckoning altogether when an exact determination of the standing-stock of such groups is not necessitated by the method to be adopted for estimating the sustained yield, or when, for any other reason, a knowledge of their contents is not considered necessary. In any case, the method to be followed must depend in a great measure on the

method adopted for determining the annual yield. When the latter is determined from an estimate of the annual increment of the whole forest—as is the case in the State-forests of Austria—it is evident that, other things being equal, a much more careful examination of the yield and increment of groups, more particularly of young groups, is necessary, than in *those cases, in which the periodic yield* is fixed by area, and the cuttings decided on for the current period are not allowed to extend without compensating allowances to areas of other periods (affectations) : there is then obviously much less fear of exceeding the capability of the forest.

In forests managed on the "primitive" system, the determination of the contents of whole groups is seldom practicable. In most cases, all that can be accomplished is the determination of the yield of the oldest age-classes, that is to say, of those trees which will probably become exploitable during the next *period, or next two periods at most* (10-40 years). In the vast irregular forests of India, which have long been subject to indiscriminate cuttings, the method hitherto followed since the introduction of more systematic working, has generally been that of test-plots, combined with the felling of test-trees : by this method, all trees comprised in certain diameter-classes are counted, and the yield of the forest estimated accordingly, either in trees of a certain class, or in cubic feet. These classes have generally been given a very wide range, as many as six inches for the oldest, and sometimes many more for the younger, classes, *being often taken as the range of a class.* By this means, the number of trees in each class is known, and the cubic contents can be roughly ascertained for each test-area, as also the increment for each class; for the purpose of determining the annual yield of the whole forest, the older classes are then made to last until such time as must elapse before a sufficient quantity of the younger classes shall have become exploitable according to the estimate. If the younger trees of a group have not been taken into account—and it will seldom be necessary to count them—they may be regarded as if they belonged to a *separate group* which is so young that its present state need not be considered for the purpose of determining the annual yield for the current period. This method is rapid, and, therefore, particularly suitable to large expanses of forest which have to be quickly organized in order that a rough, but, under the circumstances, sufficiently reliable, idea of their capability may be obtained. It may, of course, be developed to any required degree of accuracy by increasing the area of the test-plots and the number of test-trees, and by diminishing the range of the diameter-classes.

In *coppice-forests* very superficial methods will often suffice. The annual cuttings will almost always be fixed by area, and there will then be little or no fear of materially exceeding the

capability of the forest. Average returns, showing the mean annual increment per acre for the revolution chosen, may be taken from experiential tables, for the preparation of which previous annual cuttings will supply ample data ; or, if greater accuracy is desired, small test-plots may be taken up, in which case, the most expeditious way will generally be to cut down all trees on the test-plot, stack the firewood, measure up the timber (poles), and so determine the yield of the plot.

In stored coppice, the overwood may be treated in the same manner as the older age-classes of primitive forest, with separate height-classes. The underwood should, of course, be treated separately in the same way as simple coppice.

(6). Determination of the Increment of Groups.

For the purpose of determining the annual yield of a forest, it is necessary to know the probable increment of the oldest age-classes, *at least, because all groups of a period are not cut down* at once ; the majority of those of the oldest period goes on increasing until far into the period before being exploited, and for this reason the increment must be taken into account in fixing *the annual periodic yield.* Supposing, for example, that certain groups, to be exploited during the current period of 20 years, are estimated to contain 100,000 cubic feet, with an annual increment of 2 per cent., or 2,000 cubic feet. It would evidently not suffice—if we wished to work up to the full capability of the periodic yield—to arrange to cut only 100,000 ÷ 20 = 5,000 *cubic feet, annually : we could afford to cut every year a further* quantity equal, roughly speaking, to half the present annual increment of the whole, on the assumption that the growth of the groups is pretty uniform throughout. Half the annual increment would amount to 1,000 cubic feet, so that the annual yield of the period might safely be fixed at 5,000 + 1,000 = 6,000 *cubic feet.*

The *current increment* of a group is a term used to denote the growth during the past year, and is usually expressed, in cubic feet, either in percentages of the group's cubic contents, or *in absolute quantities of growth per acre, or for the whole* area.

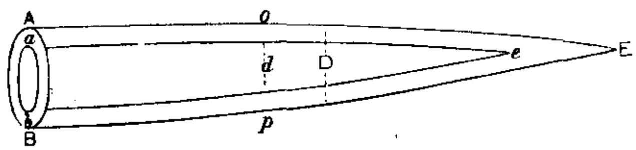
The *mean yearly growth* during a period is found by dividing the quantity of wood produced during such period by the number of years it contains. When no period is specified in connection with the average growth of a tree, or group, the term is understood to refer to its cubic contents divided by its age.

The increment may be estimated—(1), by felling and measuring the increment of test-trees ; (2), by means of form-coëfficients ; *(3), from experiential tables ; or (4), by the method of* mean yearly growth.

(1). *By means of test-trees.*

If, in the accompanying figure, ABE represent the present

Fig. 1.



volume of a tree, without bark, *abe* its volume a year ago, the last year's growth will be equal to ABE—*abe*.

The volume of ABE may be found by multiplying the area of the circle corresponding to its diameter at half the distance from its base, by its length, on the assumption that the tree is a paraboloid. Or if D represents the diameter at the centre of the *tree, C the cubic contents of the tree, H its height,*

$$C = \pi \left(\frac{D}{2}\right)^2 H = \cdot 7854 \,.\, D^2 \,.\, H.$$

Similarly, if d represents the diameter of *abe* at half its length, and h its length, its volume will be

$$\pi \left(\frac{d}{2}\right)^2 h = \cdot 7854 \,.\, d^2 \,.\, h.$$

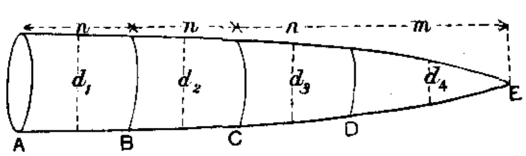
Therefore

$$ABE - abe = \cdot 7854 \,.\, D^2 \,.\, H - \cdot 7854 \,.\, d^2 \,.\, h.$$

When greater accuracy is essential, the trunk may be divided into sections, and each one cubed separately.

In the accompanying figure, each of the sections AB, BC, CD, may be regarded as the frustum of a paraboloid, and DE as a paraboloid. If the areas of the ends of a frustum are M and N, respectively, and its length n, its cubic contents will be $\frac{n}{2}$ (M + N), and the contents of each section may, therefore, be found by this formula. But a better plan is to measure the area of a circle corresponding to the diameter of the frustum at half its height. If M represent the area at that point, the contents of the frustum will be M × n.

Fig. 2.



If the sections are all of the same length, and the areas corresponding to their diameters at the centre are M_1, M_2, &c., the contents of the whole tree will evidently be equal to n (M_1 + M_2 + &c.). The terminal section, DE, would in most cases not be equal in length to the others, in which case it would have to be

estimated separately. The contents of ABE (*see Fig.* 1) may be quickly found in this manner, but it is an extremely laborious process for finding the contents of *abe*, necessitating the cutting up of the tree into pieces at d_1, d_2, &c., (*Fig.* 2.)

The growth of one year is so small that it is very difficult to measure. For this reason, and in order to obtain a more average result, it is usual to measure the growth of the last 5–10 years, and to take the mean as the current growth of a year.

In order to find the length of the paraboloid, *abe*, (*see Fig.* 1), we must deduct *e*E from AE. If, for example, the difference in age between ABE and *abe* is 10 years, it will be necessary to deduct the growth in height of 10 years. This may be done by cutting off a portion of ABE representing the growth of 10 years. The exact length to be cut off cannot, of course, be hit upon at once. A portion estimated to be about the right length is sawn off; but supposing we find, by counting the number of its annual layers, that this piece represents the growth of only seven years, it will be necessary to cut off a portion representing the growth of three years more; another piece is, therefore, cut off, and so on, until the full 10 years' growth has been got rid of. The required diameter for estimating the contents of *abe* would be found by sawing through the remaining portion of the trunk at the point *o*, at a distance from its base equal to half its length. The diameter at *o* of *abe* will evidently be equal to the whole diameter, *op*, minus the breadth of 10 annual layers on either side of the disc.

If D is found to be 1 foot: AE = 50 ft.: A*e* = 44 ft.: *d* = 11 inches: the increment for the 10 years will be

$$\cdot7854 \times 1^2 \times 50 - \cdot7854 \times \left(\frac{11}{12}\right)^2 \times 44$$
$$= 39\cdot27 - 29\cdot04 = 10\cdot23 \text{ cubic feet.}$$

The yearly increment is, therefore, $\frac{10\cdot23}{10} = 1\cdot02$ cubic feet.*

The rate of growth per cent. for the period is

$$\frac{10\cdot23}{29\cdot04} \times 100 = 35\cdot2.$$

And the rate per cent. for one year is $\frac{35\cdot2}{10} = 3\cdot52$.

Sometimes the past growth in height and diameter is measured, the future diameter and height deduced from the result, and the prospective contents of the tree calculated accordingly.

If we take, for instance, a tree of the same dimensions as in the last example, there will be an estimated diameter-growth of 12 − 11 = 1 inch, and a growth in height of 50 − 44 = 6 feet, for the next period of 10 years.

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* The contents of trees measured in this way may be most conveniently found by using tables in which the contents for any given diameter and height can be seen directly without calculation.

The future tree will, therefore, contain

$$\cdot 7854 \times \left(\frac{13}{12}\right)^2 \times (50 + 6) = 51{\cdot}62 \text{ feet,}$$

and the increment for the period will, therefore, be 51·62 − 39·27 = 12·35 cubic feet.

The rate per cent. for the period will be $\frac{12{\cdot}35 \times 100}{39{\cdot}27} = 31{\cdot}67$, and for one year $\frac{31{\cdot}67}{10} = 3{\cdot}17$.

By assuming that the growth is laid on the inside of a tree, appreciably smaller results are obtained than by assuming that the layer is formed on the outside. The difference in the above example comes to 2·12 cubic feet for the whole period, or ·21 cubic foot for one year, which amounts to just about 2 per cent. annually.

In order to obtain a mean result, sometimes the layer is assumed to lie half within and half without the present diameter. For the example just given the estimate would in that case be as follows :—

The larger diameter would be D + ½ inch : the smaller D − ½ inch. Therefore, taking the figures of height in feet and those for diameters in inches, the increment would be

$$\begin{aligned}\cdot 7854\,(D + \tfrac{1}{2})^2\,(50 + \tfrac{6}{2}) &- \cdot 7854\,(D - \tfrac{1}{2})^2\,(50 - \tfrac{6}{2})^2.\\ = \cdot 7854\,(12{\cdot}5)^2\,.\,53 &- \cdot 7854\,(11{\cdot}5)^2\,.\,47\\ = 11{\cdot}27 \text{ cubic feet.}\end{aligned}$$

A result just half-way between the two previous estimates. Which, then, it will be asked, is the most correct? The answer to this question depends on whether the current increment is rising, falling, or nearly stationary. As long as it is decidedly on the increase, the second method may be most advantageously employed : when it is decidedly falling, the first method is more likely to prove correct : but when it is neither rising nor falling to an appreciable extent, the last method is to be preferred to both. Generally speaking, therefore, the first is most suitable to groups which are long past maturity ; the third to tolerably mature groups ; and the second to comparatively young groups. The reason for this conclusion is that the current increment of a group in its very earliest stage, is slow ; soon, however, it becomes more vigorous, and goes on increasing pretty steadily for many years until it culminates ; it then falls steadily. At about the age of physical maturity, that is to say, at about the period of maximum mean yearly growth, the increment is pretty uniform for a long time, but afterwards begins to fall more rapidly. In the table at page 98, which gives the yields of spruce of the best class, according to Baur, it will be found that from the fifth to the thirtieth year, the current increment increases rapidly from year to year : it then begins to fall more or less rapidly up to the 70th year : from the 70th to the 115th year, the fall is extremely slow ; and from the 70th to the 95th, it is almost stationary. For groups with yields corresponding to the above,

the estimate of increment of trees up to their 30th year would probably be most advantageously made by the second method; from the 30th to the 70th by the first, and from the 70th to the 95th year, by the third method. The following table shews the increment for period of five years for the table above referred to :—

Age of group.	Acre-increment during period of 5 years, cubic feet.	Age of group.	Acre-increment during period of 5 years, cubic feet.	Age of group.	Acre-increment during period of 5 years, cubic feet.
5			730	85	
	357	50			500
10			642	90	
	568	55			487
15			644	95	
	859	60			429
20			586	100	
	930	65			429
25			572	105	
	1,058	70			429
30			515	110	
	1,001	75			400
35			500	115	
	944	80			348
40			501	120	
	901				
45					

Should it not be thought necessary to take into consideration *the height-increment*, the formula becomes

$$\cdot 7854\ (D^2 - d^2) = \cdot 7854\ (D + d)\ (D - d),$$

and this is the formula generally used as it saves some trouble.

In this case, whenever the increment is measured at one point only, that point should be chosen at the mid-section of the stem *after the growth in height* has been cut off.

So far, we have considered only the increment of the bole. If it is desired to find also that of the branches, those which are sufficiently shapely may be measured in the same way as the stem. But those portions which are not measurable in this way may be stacked, and their volume estimated from the known contents of stacked wood, or their cubic contents may be estimated by the water-process, already described. The mean yearly growth is then taken as the current growth. The age of the branches can be ascertained by counting the number of annual layers *at the points where they have been severed from the trunk* or larger branches.

(2). *By means of form-coëfficients.*

This method may be employed, in order to avoid the laborious procedure just described, whenever good tables of form-coëfficients are available.

The present contents of a tree may be found as shown at page 51, by multiplying together its height (to the outermost branches), coëfficient and basal area at breast-height, the usual formula for which is

$$c = a \,.\, h \,.\, f.$$

In the same way, the contents of the same tree 10 years' ago may be found by the formula

$$c' = a' \,.\, h' \,.\, f'.$$

The increment (I) during these 10 years will then be found by the equation

$$\mathrm{I} = a \,.\, h \,.\, f - a \;\; h \;\; f'.$$

The present form-coëfficient and contents can easily be found in the manner already described by felling and measuring the tree.

The dimensions of the bole when 10 years younger may be obtained in the following manner :—The required diameter at 4½ feet from the ground will evidently be equal to the present one less twice the last 10 years' growth of the radius. The area can then be calculated for it in the usual way ($\cdot 7854\ d^2$). In order to find the height, the stem must be cut away until 10 years' growth has been eliminated (see page 193) ; the length so cut off is then deducted from the height of the present tree, in order to obtain the height of the tree 10 years ago. The form-coëfficient must be assumed to have remained stationary during the period, unless we happen to have tables of form-coëfficients when they may be employed with advantage to find the probable coëfficient. We shall then be in possession of all the data necessary for a solution of the problem. The assumption that the coëfficient is stationary is, of course, wrong, but, for all practical purposes, it will suffice if the assumption be made only for comparatively few years, and if absolute accuracy, which in any case is not to be expected, be not demanded.

Example.—The extreme height of a tree is found to be 70 feet : its diameter at breast-height 16 inches, the basal area 1·4 square feet, and its cubic contents (including branches) 50 feet. Its present form-coëfficient is, therefore, $50 \div 70 \times 1{\cdot}4 = {\cdot}51$.

Ten years ago the diameter is found by actual measurement of the rings to have been 14 inches, with, therefore, a basal area

of 1·07 square feet. The height-increment during the same time is found to have been 6 feet, consequently the height of the tree then was $70 - 6 = 64$ feet. We now assume that the coëfficient is the same as that already found, ·51, or, if we have tables, from which we may conclude that the coëfficient 10 years ago would probably be ·02 greater than the present one, we may assume that it then was ·53. The contents of the tree would, therefore, be $1·07 \times 64 \times ·53 = 36·3$ cubic feet.

And the increment of the tree during the period was, therefore, according to this estimate, $50 - 36·3 = 13·7$ cubic feet, equivalent to a mean yearly yield of $13·7 \div 10 = 1·37$ cubic feet.

The modifications in the calculation of the increment (by assuming it to have been laid on inside, outside, or half on the inside and half on the outside) may naturally be employed according to circumstances by this method also; and the coëfficient may of course be taken for the stem only, or for the whole tree.

(3). *By means of Increment Tables.*

The preparation of experiential tables, which consist in statements shewing the increment during periods of 5-10 years, for all ages and qualities of a species, was explained at page 94. The practical application of such tables has also been fully explained, and it does not, therefore, seem necessary to refer again to their construction and use.

(4). *By the method of mean yearly growth.*

This kind of increment is found by dividing the contents of a group by its average age. Thus, if a group, 50 years old, has a volume of 5,000 cubic feet, its mean yearly growth would be $5000 \div 50 = 100$ cubic feet.

(*To be continued*).

A TIMBER SLIDE IN THE CHAMBA FORESTS.

An *anonymous contributor to the "Pioneer" recently de*scribed the picturesque aspect of Himalayan timber slides as follows:—

"High up the Sutlej, or the Ganges or Jumna, where the snowy *aiguilles* of the Kailas or Raldung range sheds its milky white tor-

rents, through valleys densely forested with the deodar and all the largest trees of the Himalaya, the sportsman often crosses on the mountain side great timber shoots, the heads of which are lost in the mountain's silvery necklet of birchwood, while their feet are laved by the torrent below. Deodars and many other pines, stately walnuts, sturdy hill oaks, ruddy rhododendron and sombre, bristling holly enclose this steep avenue; the ring of axes breaks the silence of this world, the crash of falling forest monarchs echoes and vibrates across the valley to the opposite cliffs, disturbing the Thar and Lammergeier that alone rest there, and the quivering air liberates a tottering cliff of snow high above the traveller's path; such are the sounds that tell him that he is nearing the home of the Hill Forest Officer.

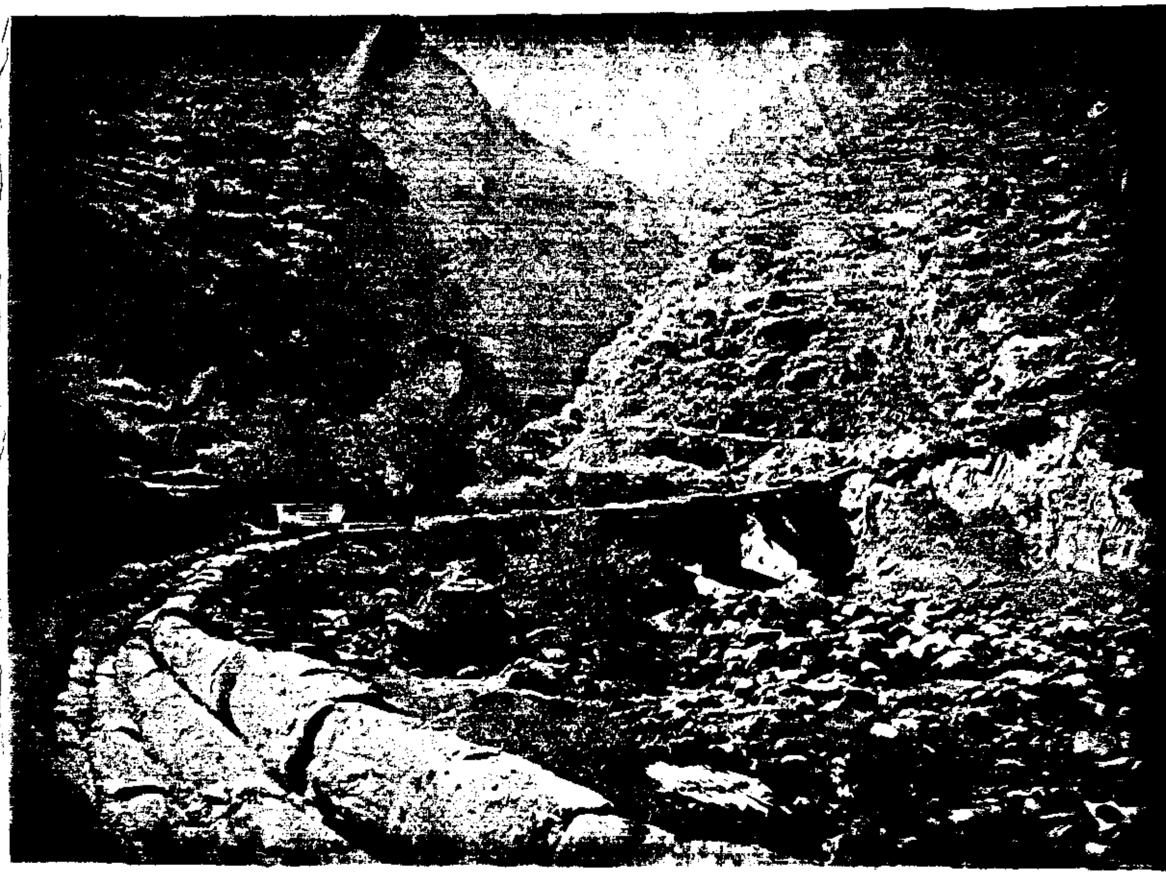
* * * * * * * * * *

The windows look over the mighty mountain river, that is his great forwarding agent. Beyond, to north and west, the snow-peaks bound the view. At the back of the house the pine-woods rise steeply, and a sweet odour of them is always in the air, and at night their whisperings after his hard day's work are a very effective lullaby. Macbeth himself would not have to seek for a soothing syrup here. And all the time the river is noisily bearing away the timber tribute (duly marked by the Forest Officer's men) that the lesser streams bring to it from the shoots, down through dark defiles, under the cold gleam of blue glaciers, through the hot bamboo-feathered foot hills, out to the great depôts at Rupar, or elsewhere, where the rivers debouche into the plains and there are relieved of their flotsam; what was cast upon the waters is found again after many days."

I am indebted to Mr. McDonell for an account, from a more practical and business point of view, of the construction of a slide built by him on the Ravi in Chamba, of which I had recently an opportunity of taking some photographic views. The slide is the largest, I believe, which has yet been constructed in India, and is an admirable example of forest engineering.

The forest to which the slide has been built has an area of about 1,700 acres, and is situated in the basin of a small nala which flows into the river Ravi about 10 miles above Chamba. The bed of the Ravi where it is joined by this nala is only 3,300 feet above the sea, but the forest occupies the upper portion of the nala, and extends up the steep slopes of the hills bordering it from 5,500 feet to 9,000 feet above the sea level. These hills, which jut out from the main outer Himalayan chain, rise on three sides of the forest to an elevation of about 10,000 feet, and a peak on the main ridge to 14,000 feet; yet so steep are the slopes that the distance from one side of the basin to the other at its upper limits is scarcely 3 miles.

Like all the *deodar* forests in Chamba it contains a large number of mixed species, such as spruce and silver firs with oaks, maples and other broad-leaved trees. Deodar, which at present is the only marketable product, is very unequally distributed, and does not form more than one-fifth or one-sixth



TIMBER SLIDE IN THE CHAMBA FORESTS

of the crop. But the trees are magnificent specimens of their kind, and are nearly all mature. For owing to its distance from the river and the difficult nature of the country, no trees have been felled in the forest except a few cut by villagers residing in the immediate vicinity. Some of the trees measure over 21 feet in girth, and the average girth of the mature trees was found to be nearly 10 feet. The cubic contents of the *logs* cut from 1,200 trees recently felled was 1,32,800 cubic feet, equal to 194 cubic feet of workable timber per tree. The growth is rapid for deodar, 9 to 10 rings on an average per inch of radius, and it is estimated that the forest can yield nearly 6,00,000 cubic feet of deodar timber at the first exploitation.

As the small nala, in the basin of which the forest is situated, is useless for the extraction of timber, being merely a narrow rocky torrent almost dry except during a few days in the rainy season, it occurred to the Divisional Officer, Mr. McDonell, who was assisted by the professional knowledge of Mr. Copeland, then *attached to the Chamba Division, that a road could be* made from the forest to the river at a sufficiently low cost to admit of the timber being extracted by it at a profit.

The construction of this road presented considerable difficulties. The only outlet from the forest is by the nala which, for a long distance, runs through a narrow rocky gorge bounded by almost sheer walls of rock several hundred feet high. Beyond this the slopes of the hills, which are formed of clay slate rock, very friable at the surface, are so steep that landslips are of constant occurrence. Labour is difficult to procure in Chamba, there are no skilled labourers, and none of the subordinate establishment had ever seen a large slide or work of the kind.

The head of the slide was fixed at the point where the bed of the furthest ravine down which logs are brought joins the stream. The distance of this point from the Ravi was found to be 12,376, and the fall to the main river 1,650 feet, giving an average gradient of 1 in $7\frac{1}{2}$. But this gradient has not of course been uniformly maintained throughout; in order to keep the cost of construction as low as possible, the logway has been *made to follow, as far as practicable, the configuration of the* ground. The slide runs along the left bank of the stream for a distance of about 8,100 feet, and then, in order to avoid difficult ground and a long landslip, crosses* over to the right bank, and runs along it for the remainder of its course.

The general design is a "way" for the logs in the form of a concave channel contrived by placing four to five logs side by side. The deodar logs felled for exportation have been used

* The photograph has been taken just below this point, which is outside the forest. It was not possible to obtain a good general view of the slide within the forest.

in forming this channel, as they will not be injured by the working of the slide, and when the supply from the forest is exhausted they will be taken up and brought out by the slide itself to the river. The channel can take logs up to 6 feet diameter, or 18 feet girth; larger logs than this have to be cut into beams.

Where the slide runs in embankment the logway or channel is supported on piers built of logs, of some strong but inferior species, such as oak, placed crosswise, one above the other on their notched ends, like the frame-work of an American log hut, and filled in with boulders and broken stones. This stone packing gives the necessary solidity to the structure, while the wooden frame work enables the piers to resist the vibration caused by heavy logs passing along the slide at great speed better than any masonry walling could do.

The most difficult and expensive portion of the work was the clearing of a passage for the slide through the narrow gorge already alluded to. The cliffs on either side of this gorge are of exceedingly hard, sub-crystalline slate, which requires an enormous amount of labour to break up. A passage was made partly by blasting a way out of the rock along the perpendicular face, and partly by cutting away projections and bridging the intervening spaces, a foundation being blasted out for the pier on each side. The work turned out far heavier than was expected; the rock, thought to be soft, being in reality extremely hard, and requiring an enormous number of blasts to clear a way for the logs. It was at first intended that the crossing of the stream should be made by a level bridge on a roller principle; but when 1,000 feet of the logway had been completed, some thirty logs were sent down as an experiment, and it was found that the logs, once started, travelled of their own accord down an incline of 1 in $7\frac{1}{2}$, increasing or decreasing in speed according to the degree of wetness of the slide. This knowledge attained, it became necessary to alter the design of the bridge, and it was decided to continue the log channel over the bridge, at the same gradient as the approach.

The work was made up of two great classes, *viz.*, excavation and pier walling. The former was of four kinds:—

I. Earthwork simply.
II. Stony soil, requiring the pickaxe.
III. Rocky, requiring pick and some blasting.
IV. Rock, requiring to be blasted entirely.

The construction was commenced during May 1883, and it was expected it would be completed before the floods of 1885, but owing to various causes, such as bad weather, unexpected difficulties and landslips during the winter, the work ran on until the 31st October, when the last log was laid, the first log being launched into the Ravi on the 2nd November, 1885.

The cost of constructing the slide has been as follows :—

Particulars of work.	Amount.	Remarks.
	Rs.	
Excavation, 2,00,000 cubic feet, @ Rs. 1-4-6 per 100 cubic feet, ...	2,562	The quantities of work done were only roughly measured up, as daily labourers alone were employed.
Blasting, 90,000 cubic feet, @ Rs. 10-0-8 per 100 cubic feet, ...	9,054	
Walling, 2,50,000 cubic feet, @ Rs. 4-2-6 per 100 cubic feet, ...	10,388	
Bridge, cost of construction, ...	1,257	
Fixing logs in slide, ...	5,508	
Miscellaneous charges, ...	2,290	
Total cost, Rs., ...	31,059	

The longest log sent down the slide as yet was 48 feet in length; it passed down a distance of 2,500 feet at the rate of over 20 miles in an hour. The largest log in point of cubic contents was 27 feet long, with a mean girth of 14 feet 9 inches, containing 367 cubic feet. The number of deodar logs used in the logway was 3,999, or about 1 log for every 3 running feet of the roadway.

The labour employed was for the most part imported from Badrawar in Kashmir, the Chamba villagers were either too lazy or too well off to care to work on it. The rates varied from 2½ annas for boys to 5 annas for men. The establishment employed to supervise the work consisted solely of the Forest officials belonging to the Chamba Division, and comprised one Forester, on Rs. 15 a month (subsequently promoted to Rs. 20) and three Forest Guards. The whole of the work was done by daily labor; it was not found practicable to do any of it by contract, as from the novelty of the work rates could not be framed for contract works.

Common country gunpowder made on the spot was used for blasting; for the most difficult parts a small supply of Nobel's dynamite cartridges (150 lbs.) was obtained from Bombay, but this, though much more powerful than gunpowder, was found far too expensive to be used on a large scale.

In a work of such magnitude and such a nature it was hardly to be expected that accidents of some kind would not occur; every care was taken, and men were employed as signallers in every description of work, but still there were six fatal accidents. Four men were killed by falling trees, one man was crushed to death by a log in the slide, and one man fell through a bridge and fractured his skull. Besides these cases a few men were injured, the worst case necessitating amputation of the leg. There were

no accidents from dynamite or gunpowder ; a matter for congratulation, when it is considered that 150 lbs. of dynamite and 8,450 lbs. of gunpowder were exploded. On an average 12 oz. of powder were used to each blast, and in all 11,500 blasts on the whole work, and with this some 90,000 cubic feet of rock was cut away.

The following is a forecast of the profit likely to be derived from the work. Only a rough estimate is, however, possible, as there are so many contingencies to take into account, such as losses in transit, non-occurrence of floods in the Ravi, damage to the slide from landslips, &c. The cubic contents of the timber it is contemplated exploiting by the slide has been estimated at 5,69,000 cubic feet :—

Dr.	Rs.
First cost of slide, ...	31,059
Estimated cost of its repair during the three years the forests are being worked, ...	5,000
Estimated cost of auxiliary slides in forest to bring logs to the principal slide, ...	20,000
Cost of bringing the timber to head of slide; 5,69,000 cubic feet, at Re. 0-1-3 per cubic foot, ...	44,453
Cost of taking the logs down slide to Ravi, 5,69,000 cubic feet, at Re. 0-1-0 per cubic foot, ...	35,562
Cost, allowing for a loss of 10 per cent. in transit, of transporting 5,12,100 cubic feet to Lahore and landing at the depôt, at Re. 0-2-9 per cubic foot, ...	88,017
Estimated contingencies, ...	1,909
Total Rupees, ...	2,26,000
Cr.	
By sale of 5,12,100 cubic feet of deodar timber at Lahore, at Re. 0-12-0 per cubic foot, ...	3,84,075
Estimated net profit, Rupees, ...	1,58,075

The selling rate is only taken at 12 annas to allow for a certain proportion of the logs being broken during transit to the sale depôt, a distance of several hundred miles, and thus fetching only low prices, but as many of the logs will be over 20 feet in length, the selling rate for which is Rs. 1-4-0 at the depôt, the above estimate should be well within the mark.

W. E. D'A.

THE RINGAL OF THE NORTH-WESTERN HIMALAYA.

I HAVE suggested to the Editor to reprint the following paper in the "Indian Forester," in the hopes of inducing some of its readers to study several points, which are as yet doubtful in regard to the life history of these and of other bamboos.

As far as I am aware, *Arundinaria spathiflora* belongs to those species which flower gregariously, that is, all stems of one bush flower at the same time, and all bushes in one locality are in flower simultaneously. To the gregariously flowering bamboos belong, among others, *Bambusa arundinacea*, the common Katang, *Bambusa polymorpha* and *Cephalostachyum pergracile*, the Kyathonnwa and Tinwa of Burma. Exceptions are not wanting, that is, there are occasionally individual stems or bushes in leaf, while the rest around them are all in flower, but the rule is, that the great mass of the gregariously flowering bamboos in one tract of country flower and seed at the same time.

Arundinaria falcata on the other hand, if I am not mistaken, is more analogous to *Dendrocalamus strictus*, the common Indian bamboo, which flowers irregularly, a few bushes only being in flower in one locality, or a few stems only in one bush.

Those species which flower gregariously, do so at long intervals, and the question is, whether they come into flower after having attained a certain age, or whether they flower, not at any prescribed age, but at any period when full grown, and the circumstances of the season are favorable to their flowering. In the case of *Bambusa arundinacea* there are facts, detailed on page 565 of the "Forest Flora for North-West and Central India," which seem to indicate, that this species flowers, when it has attained an age of about 30 years. These are matters regarding which more observations are wanted.

Another question is, whether in the case of bamboos, and particularly in the case of these two hill bamboos, the rhizome dies with the seed-bearing stems. When all bushes in a forest of gregariously flowering bamboos have flowered and seeded, the ground gets covered with a dense mass of seedlings, not unlike high grass. This fact is familiar to all foresters of some experience, but the question is, whether some of the rhizomes do not remain alive and send forth coppice shoots among the seedlings.

There seems also to be a question, whether the leaf-bearing stems of the smaller hill bamboo, *Arundinaria falcata*, do not die down annually, an entire crop of fresh stems being formed in spring.

There are many other points regarding the life history of these and other bamboos, which demand further research. Most of them are adverted to in the remarks regarding bamboos in my Forest Flora. I thought, it might be useful, again to draw attention to them upon the present occasion.

An acccurate description of the rhizomes of the two hill bamboos, and of their development from the seedling plant onwards, would be most interesting. The same remark applies to all bamboos. Should it be in the power of any Indian Forest officer to send me young rhizomes of different species, with pieces of old rhizomes of the same species, I should be very glad to examine them.

BONN: March 1886. D. BRANDIS.

NOTES ON TWO SPECIES OF *Arundinaria* SUITABLE FOR CULTIVATION IN NEW SOUTH WALES.*

[*Read before the Royal Society of N. S. W., 7th October,* 1885].

Two species of bamboo are known from the higher mountains of the North-Western Himalaya: *Arundinaria falcata*, Nees (Munro in Trans. Linn. Soc. XXVI., 26), and *Arundinaria spathiflora*, Trinius, described by Munro under the name of *Thamnocalamus spathiflorus*.

Arundinaria falcata is a small bush, not much over 6 feet high, growing at moist places in the valleys of the outer North-West Himalaya. I have found it in Kulu in the basin of the Bias River, on tributaries of the Sutlej River, and in the valleys of Jaunsar, leading to the Tons and Jumna Rivers. I have never seen it at a higher level than 7,000 feet. The stems are thin and weak, and do not, as far as I know, form any article of trade. The bamboo, which is exported to the plains of Hindustan, and which is made into tubes for water tobacco-pipes (hookah), fishing-rods, mats, baskets, is *A. spathiflora*, a much larger species, which grows at from 8,000 to 10,000 feet. This is the kind commonly known as Ringal, Nagal or Ningala. In the forests of *Cedrus Deodara, Cupressus torulosa, Abies Smithiana, Abies Webbiana* and *Quercus semecarpifolia* it often forms a dense underwood, covering large areas on the ranges between the Ravi and Bias, Bias and Sutlej, Sutlej and Tons, and Tons and Jumna Rivers. This bamboo also forms forests of its own, with a few scattered trees. Such a forest, consisting chiefly of *Arundinaria spathiflora*, I found in October 1874, on the south side of the Kidar-Kanta Peak of the Tehri State, in a moist valley, on excellent soil, and here the stems had attained 30 feet.

Both species have a wide distribution, but as far as is known they are limited to the outer ranges with a moist climate. They have not been recorded from the drier districts beyond the

* By DR. BRANDIS, F.R.S., late Inspector General of the Forest Department of British India. Communicated by Baron *Ferd. von Müller, K.C.M.G., M.A., Ph.D.*, F.R.S., &c., Govt. Botanist, Victoria.

Snowy Ranges. According to Munro, *A. falcata* extends from the Ravi to Kumaon, and is again found on the Khasia Hills. As to elevation, the limits given by him (5,000 to 7,500 feet) accord with my own observations. *A. spathiflora* has its north-west limit on the hills between the Ravi and Bias, and, according to Munro, is found in Sikkim and Bhutan. As already stated, its limits of elevation are 8,000 to 10,000 feet.

When I wrote the "Forest Flora of North-Western and Central India" in 1874, my knowledge of these two species was somewhat imperfect, and the account given of them by me on that occasion was not altogether correct. Since then I have had opportunities of studying them better, and it may therefore not be out of place to give a fresh description. This description is limited to the parts above ground. The rhizome or underground stem of these species, like that of the *Bambusæ*, is much branched and twisted; but I am unable to state whether there is any difference in the shape and mode of growth in these two species. From these rhizomes, when fully formed, spring every year a small number of stems, which at first are soft and succulent, unbranched and leafless, but bearing at the nodes large sheaths or spathes, which, while the stems are growing, cover the internodes and overlap each other, giving to the upper portion the appearance of a telescope not quite drawn out. From the axils of these large sheaths spring leaf-bearing branches; and while these develop, the stems harden and become woody. In the case of *Arundinaria spathiflora* the stems last a number of years, and as every year new stems are formed, the clump or cluster of stems, which springs from one rhizome, gets dense, often containing more than 100 stems. The clumps or clusters of this bamboo stand close together, generally forming extensive thickets, so that adjoining clusters cannot readily be separated. When the stems have attained a certain age, they flower and die after ripening their seeds. I do not maintain that they always flower at a certain age; this probably varies according to circumstances, but this bamboo always flowers over large areas. I have collected flowering specimens in Jaunsar, on the hills between the Tons and Jumna Rivers, at 9,000 feet, in May, 1881, but I have observed the species in flower on several occasions in other places. I am unable to say whether in this species the rhizomes die with the seed-bearing stems. On this as on many other points further observations will be most welcome.

Of *Arundinaria falcata* Munro says, that the stems are annual. Royle (Ill. Himal. p. 23) says, that the annual stems of the hill-bamboo are yearly beaten down by the fall of snow, which protects its perennial roots from excessive frost. In this passage Royle speaks of a bamboo which grows from 7,500 to 10,000 feet, and which must be *A. spathiflora*, the stems of which, as far as I know, are perennial. *Arundinaria falcata* I have col-

lected in flower and in seed on many occasions; at Chakrata (6,000 feet) in April, 1881, in the Valley of the Manglad, a tributary of the Sutlej River (6,000 feet) in May, 1881, in Jaunsar in September, 1878, and in Kulu in October, 1876. I readily believe that in the North-Western Himalaya the stems are annual and flower annually, but I have no observations upon the subject.

I now proceed to give a brief account of the characters by which these two species can be best distinguished. *Arundinaria falcata*, Nees: stems 6 feet high; internodes 6-12 inches long, $\frac{1}{2}$-$\frac{1}{3}$ inch diam.; nodes much thickened. Sheaths on young shoots thinly membraneous, glabrous, with apex 4·12 inches long, gradually narrowed into a subulate point. Leaves 3-4 inches long, $\frac{1}{4}$ inch broad, glabrous above, with scattered long soft hairs beneath; midrib prominent; of the numerous longitudinal nerves 3-5 pair more distinct than the others; no transverse veins. Apex of sheath without ciliae; ligule small, obtuse. *Flower-bearing stems leafless; numerous slender* branches in compact half-whorls. Spikelets $\frac{1}{2}$-$\frac{3}{4}$ inch long, with 1-2 fertile and one terminal sterile flower. Flowering glume glabrous, 7-9-nerved. Palea as long as flowering glume, two-keeled, with longitudinal nerves outside the keels; three small fimbriate scales; style 2-fid to the base.

Arundinaria spathiflora, Trinius.—Stems to 30 feet high; internodes 6-15 inches long, $\frac{1}{2}$-$\frac{3}{4}$ inch diam.; nodes not much thickened. Sheaths on young shoots (spathes) glabrous, coriaceous, narrowed abruptly into a distinct linear caducous apex; sheaths without apex 6-8 inches long. Leaves 3-5 inches long, $\frac{1}{3}$-$\frac{1}{2}$ broad, glabrous, with three pairs of prominent longitudinal nerves on either side of midrib; conspicuous transverse veins dividing the area of the leaf into squares; leaf narrowed into a short petiole, which is articulate with sheath. Leaf-bearing sheath 2-3 inches long, coriaceous, with prominent longitudinal nerves, fimbriate with long ciliae at apex, persistent after the leaves fall, forming an acute angle with the branch. Flowering stems generally with a few leaves; flowers in long panicles, with elongated drooping branches. Racemes of 2-3 spikelets in *the axils of large clasping multinerved leafless sheaths, which* are fimbriate at the apex like the leaf-bearing sheaths. Spikelets lax, 1-2 inches long, of 6-8 flowers. Flowering glume hairy outside; palea much shorter than flowering glume, with 1-2 longitudinal nerves between the keels; 2-3 falcate scales; styles 3-fid to base, long-plumose.

The bamboo described by Major Madden as *Arundinaria falcata* (Ringal), page 614 of Journal Asiat. Society of Bengal, June 1849, is doubtless *A. spathiflora*, also that mentioned by Dr. Cleghorn as *Arundinaria falcata* and *utilis* from several places in the North-West Himalaya, in his Report upon the Forests of the Punjab, 1884. Munro in his Monograph on Bam-

boos (1868), quotes Royle and Cleghorn under *A. falcata*. Dr. Stewart, in his Punjab Plants, 1869, identifies the Ringal of commerce with *Arundinaria falcata*, Nees ; and, as already mentioned, I did not on page 562 of my Forest Flora (1879) give a completely correct account of these two interesting Bamboos.

BONN, *18th July, 1885.*

Baron Von Müller, in forwarding the above paper of Dr. Brandis to the Hon. Secretary of the Royal Society of New South Wales, refers to the same in the following words :—"These two species of bamboo had been so often found mixed up in works on Botany, that I deemed it advisable to refer the matter directly to the best authority extant, in order to obtain satisfactory information. I, myself, have first introduced into Australia many living bamboo species, and probably was the first who encouraged their propagation from seed in many parts of the globe. As they are such beautiful and graceful plants, of which there are about 200 species, the publication of Dr. Brandis' important notes on two of the kinds of *Arundinarias* may appear advisable, so as to direct more attention towards them, especially since *Arundinaria spathiflora* is still dragging itself through many botanical works under the name of *Arundinaria falcata*.

AU REVOIR.

AFTER ten years' service in India I find myself definitely transferred to the other side of the Indian Ocean ; and I take the opportunity afforded by the "Indian Forester" to bid adieu to brother Foresters in India. Many friends I hope to see again either here or at home. There is the hope that as the forest and game is conserved and restored on these beautiful mountains, the Cape will again see an influx of English sportsmen and Anglo-Indians in search of health. If there were direct steam communication from India to England, *viâ* the Cape, many would choose that route for the sake of the longer voyage and the avoidance of the Red Sea. Political complications may close the overland route. Then again people run backwards and forwards from the Cape very much more than from the other great Southern Colonies, it being only about one-half the length of the voyage to the Australasian Colonies. The rules of the Cape Civil Service are very similar to those of the English Civil Service—6 weeks leave per year accumulating to six months, and longer leave for sickness or private affairs.

Undoubtedly, however, the strongest tie to the old service and early friends is the "Indian Forester." This arrives regularly month by month, and keeps one within touch of the Indian forest world. I am in a greatful mood, and should like to re-

cord my sense of the value of the "Indian Forester." Recently I had to give a lecture, at somewhat short notice, and with shorter leisure for preparation. I had little but the "Indian Forester" to refer to, but there was a treasury of facts and figures.

It is perhaps we distant members of the "ancient order" that can best appreciate the usefulness of such a publication, and from whatever side support may come, that it may be sufficient for a steady growth is the earnest wish of an old supporter and now distant contributor.

D. E. H.

ACER SIKKIMENSE.

I NOTICED some time ago, in Senchal, Darjeeling, two maple trees, which seemed to me the *Acer sikkimense*, in flower. On a reference, as usual, being made to Mr. Gamble's "List of Trees, Shrubs, &c.," for the district, the description, in page 22 of the book, agreed in points respecting this tree, except the inflorescence, which Mr. Gamble has put down as *spicate.* I, on the other hand, observe that the flowers are borne on short stalks, and consequently the inflorescence is a pedicillate (and not *spicate*) raceme. In order to avoid mistakes, I have collected a few specimens of the leaves and flowers, and intend to forward to you for the determination of the species, as soon as these are dried. In the mean time, I shall be very thankful, if Mr. Gamble kindly informs me, through the medium of the "Indian Forester," that the above description given by me corresponds with any other species of maple.

AN EX-STUDENT.

A CORRECTION.

IN the Article on *Continued Growth of Pine Leaves*, which appeared in the February Number of the "Indian Forester," two misprints on page 58 should be corrected :—

The name of the Chemist, who made experiments regarding the leaves of *Prunus Laurocerasus* is *Corenwinder*. And near the bottom of the page the sentence should run thus :—Leaves just formed ..... have *thin* walled cells.

BONN : *March, 1886.* D. BRANDIS.

LIGHT GRAZING IN BERAR.

WE have, during the last few months, published a series of articles on the above subject, which was brought prominently before Forest officers by a Resolution of the Government of

India, circulating Mr. Drysdale's report and recommendations. In our Number for March 1886, "E. G. C." blames the Government of India for having accepted the success of the experiment made in Berar after only one year's trial, and for having circulated the information in an official form.

We have all along been of the same opinion, and we anticipated that the effects of the circular would be misleading and probably mischievous. Under these circumstances it would be natural to lay the blame on the Inspector General of Forests, who is the adviser of the Government of India on forest matters.

Before condemning that officer, we desire to draw the attention of our readers to the fact that, until a short time ago, the Inspector General of Forests stood quite alone, and that, during his prolonged tours of inspection in remote forests, the Government of India was often left without professional advise. Important cases were sent to him in camp, but a good portion of the business, which appeared to be of the nature of routine work, was disposed of without his knowledge. We are informed that the issue of the circular in question came under the latter category, and that the Inspector General of Forests was, in the present instance, not aware of the issue of the circular, until he saw it in print.

Our readers are aware that the defect in the organization has now been rectified by the permanent appointment of an Assistant Inspector General of Forests, whose most important duty is to attend to the forest business of the Government of India during the Inspector General's absence on tour, and to see that no cases are disposed of as matters of routine, which require professional consideration.

FOREST ORGANIZATION FOR BEGINNERS.

I HAVE to thank 'C' for a very necessary correction of an error at page 53 of my paper on Organization.

He also refers to the expression *coëfficient*, and seems to consider *reducing-factor* a preferable term. I chose the former because it is a good English term, and much less clumsy than the latter, which is an awkward translation of the German word.

THE WRITER OF THE PAPER ON FOREST ORGANIZATION.

III. NOTES, QUERIES AND EXTRACTS.

THE UPPER BURMA FORESTS.—*The remarks on the subject of* the forest leases contained in your issue of 2nd instant, I infer, are in reply to what appeared in the *Bombay Gazette* of the 18th ultimo on the same subject. I hope you will allow me space to go into this matter more fully. What I deem chiefly necessary to bring forward is, whether the leases in Upper Burma can be called a monopoly or not. In the *Statesman* of the 26th September, 1882, *in an article lauding the Corporation, there appear* the following passages :—" The present high price of teak timber in the various markets of the world may be said to be almost entirely due to the success of a *single firm* and to the exportation of the article being declared a monopoly by the King of Burma under General Fytche's treaty. The Bombay-Burma Trading Corporation have now, too, the principal saw *mills in Rangoon and Moulmein, and may be said almost to be* the only exporters to places outside of Burma." In the issue of the same newspaper of the 25th November, 1882, a Moulmein correspondent took these remarks to task, and, among other things, pointed out that this single firm of capitalists was not the one with the enormous capital which on that occasion it was intended to bring to the prominent view of the public, and this writer *ended his subject by putting the query as to whether* some scheme was then in the air to increase their capital, a move in that direction, during the previous year, not having been carried through. After this retort nothing appeared again in the papers to glorify the Corporation until the other day, when the *Bombay Gazette* took up their cause. Formerly it suited the Corporation to announce, by a flourish of trumpets to the world at *large, that they had the monopoly of teak. Now, however,* this does not suit them any longer, as no sooner they find that those more immediately connected **with the teak trade agitate** and cry out against their monopolies in Upper Burma and memorialize the Viceroy to have the forest leases cancelled, an editorial appears in the *Bombay Gazette* stating, to the surprise of those who know better, that it is an altogether erroneous impression that the Company has a monopoly of the Upper Burma timber trade!! As will be seen from part of the memorial which you have published, the mercantile community ask only for what they can reasonably expect : to be dealt with on principles of *free trade and open competition.* If the present leases

are not cancelled, the leaseholders would inevitably have the complete monopoly of the timber trade for all Burma, not only in Rangoon, but also at Moulmein. Now that the memorial has been published, any one who has studied the subject carefully must come to the conclusion that the Corporation have but shadowy rights in the forests of Upper Burma. In order to obtain problematical extension of their leases had not "benevolences" continually to be paid? Now, supposing that the Shan Chiefs who were massing troops some time ago in their territory, had attacked and deposed Theebaw as they intended to do, would the princeling who would have got on the throne have recognised these leases? Certainly not. Now the memorialists suggest no drastic course, but submit to the Viceroy that if the leases be cancelled liberal compensation be given to the leaseholders, but that in the interest of the public before such compensation be offered there be held an investigation into their claim, and which should be conducted openly by an influential Commission of Enquiry, with full powers to thoroughly sift all the evidence produced before it.

In the letter addressed by our Government to the Foreign Minister at Mandalay on 28th of August last relating exclusively to the dispute with the Bombay-Burma Corporation, it is said that they, the Corporation, court full inquiry, and the sooner Government gets the matter investigated the better for all concerned. That King Theebaw has been deposed should not be taken as an excuse to shirk enquiry. It will never do to allow such remarks to go unchallenged and to take root, as recently have been made use of in a paper on Burma, which was read on 22nd January last at a meeting of the Balloon Society, and which is published in the summary of Home News in the *Indian Daily News* of 19th February last. Dr. Clarke, M. P., there is reported to have said "that the pretext for annexation was perfectly unjustifiable, and that the excuse for swallowing Burma was caused by the British Burma Trading Company who took the King's timber without paying for it. That the Company was fined, but that our Government objected to their paying, and sent our soldiers there, declaring the Burmese to be our subjects, and those who resisted, rebels." Surely the Corporation will see themselves the necessity of proving that they did not do any wrongful acts? It is, however, generally admitted by those who know something of how the forest leases were being worked, that a great deal requires to be cleared up before *ex-parte* statements of the Corporation's servants as conclusive evidence can be accepted that they were in the right. The most amusing and inconsistent statement which the *Bombay Gazette* makes is, that the Corporation's whole policy has been in the direction of conservancy. Such a course would be entirely preternatural. No doubt, when the Forest Department takes charge of the King's Ningyan forests, it will be shown in how far these

assertions of your contemporary, in support of the Corporation, are correct. There could scarcely have been any other motto than *apres nous le deluge*. And in what inconsistency that paper further indulges by saying that, were Government to cancel the forest leases in Upper Burma the Moulmein community would run up the prices of teak immediately to an inordinate extent! Now the article from the *Statesman,* quoted at the beginning of this letter, shows that the Corporation took the credit of running up prices in 1882, and as in former years prices were moderate, it stands to reason that the teak trade having existed in Moulmein long before the Corporation managed to secure the monopolies in Upper Burma, it is not the Moulmein community but the Corporation which has to be feared. Their manipulations in late years have been entirely in the direction of cutting out everyone, and they made no secret of it. What will the result be if they are to retain the forests in Upper Burma under the present altered state of things? Competition from Moulmein must die out, and then the Corporation will run up prices as it may suit them. The forests will also be ruined for all time. In order to preserve the forest tracts in Upper Burma, it is absolutely necessary that the Forest Department be made to take immediate charge of them, and that the leases be abolished. Should Government, after investigation, find that the leaseholders are entitled to compensation, such instead of being a direct monetary payment could take the shape of negotiable Government securities, payable over a number of years out of the revenue from the forests in Upper Burma. The same might bear interest at about 4 per cent. per annum, and be redeemable at the rate of 5 to 10 lakhs per annum. This would not prove any disadvantage to either party, as Government would be collecting a good forest revenue and could easily afford to pay compensation out of the same, and the holders of the securities could turn them into money whenever they might choose to do so. I understand that the net revenue of the Tounghoo and Sittang forests last year amounted to about 17 lakhs of rupees, so that in the case of the Upper Burma forests, which would yield a better revenue, it would be a matter of ease to spare part of this sum, and *this without touching the pocket of the tax-payers.* This would have the advantage also of putting some money into the coffers of the State, which are at a low ebb, and are partly to be replenished by the obnoxious income tax.—TECTONA GRANDIS.—*Pioneer.*

A REMARKABLE DISCOVERY.—An American inventor, Mr. Jennings, of Boston, has afforded the world another striking illustration of Boyle's invaluable piece of natural philosophy—that "there is no one thing in Nature whereof the uses to mankind are fully understood." The drying property of warm air has been known more or less for ages, and yet a simple applica-

tion now brought scientifically in use promises to revolutionise whole departments of human industry. To discover some method of drying quickly, and without injury to the material, such substances as green mahogany, slabs of English oak or elm harvested in wet seasons, hides and skins, wool, and various descriptions of fibres when thoroughly saturated with moisture, damaged rice, tea, coffee, and a hundred other materials of commerce, has exercised unlimited skill and industry in vain. Hot-air methods and the drying-kiln have been tried and given up as failures. They warped the timber, made the grain of leather harsh and rough, spoiled the flavour of tea and the colour of coffee, turned rice yellow, and failed to save the farmer's grain. No problem ever seemed simpler than the mere extraction of moisture from the substances we have enumerated, and yet few have more obstinately baffled human ingenuity. A solution has now been found to this problem in the "Cool Dry Air Process." The name indicates the whole secret of its success. Materials to be dried are placed in a chamber through which a current of moderately-warm dry air is passed continuously, and the test of experience shows that air so deprived of moisture acts as an absorbent in a manner that without such a test would have been deemed impossible. In the first instance, the current is drawn through a small furnace in which it is heated to about 600 degrees F. At this temperature the atmosphere is of course without trace of vapour. After being thus heated it is cooled by a vigorous circulation of external air which lowers the temperature to between 80 degrees and 90 degrees, and in this condition is propelled by fans, driven by steam through the drying chambers. Within these chambers the temperature is that of a hot summer's day, but the air is so "greedy" of moisture that everything within its wonderfully penetrative influence is desiccated. A machine erected on the principle is working at Messrs. Smith's extensive saw-mills, Commercial Road, Pimlico, and there the practical operation of the system has shown some results that are equally remarkable from a scientific as well as from a commercial point of view. A package of wool, 1 lb. in weight, was saturated with water; it then weighed 3½ lbs., and in this condition was placed in the drying room. In 28 minutes the moisture was almost wholly evaporated. Timber, as is well known, takes years to season. It has a perfectly surprising power of absorbing and retaining moisture. Thus 44 cwts. 2 qrs. of birch were subjected to this process for 94 hours, and then examined, when it was found to be completely "seasoned free from checking, rents, or warping," and it had given out in the operation 10 cwts. 2 qrs. 24 lbs. weight of water. Strange to say wood so treated shows no evidence of any change beyond the dryness of its substance, and this appears to be uniform throughout. Tested even by the microscope, the fibre and cells seem to be unchanged; they are

as close, but no closer, than before, and there is no perceptible shrinkage in dimension. Some lengths of ash give still more striking results. Out of 47 cwts. 3 qrs., no less than 21 cwts. 1 qr. of moisture was extracted; 22 cwts. of mahogany yielded 6 cwts. of moisture in 96 hours, whereas to obtain the same result by ordinary exposure would have taken years to accomplish. British oak is a very stubborn wood to season. Some logs, two inches thick, were finished in nine days, which by natural drying would have required three or four years. These effects were accomplished with a current of 6,200 cubic feet per minute; and the great lesson they teach is that all the mischiefs hitherto produced by drying systems accrued from the excessive heat. In this process the temperature never exceeds blood heat; and as a consequence, delicate fibres, fabrics, and chemicals are uninjured. The industrial value of this important discovery can scarcely be over-estimated. A technical journal computes that in the matter of Indian tea alone, cool air drying would probably give it such an advantage as to increase its saleable value £200,000 a year. The scientific and social interest is not less significant. It appears that fish, fresh provisions, and fruit may be preserved for an indefinite time after being subjected to this mode of treatment. It is stated that "a beef steak cut from the loin a year ago, and dried at 75 degrees F. in one hour, is as sweet to-day as when cut, and would keep for years; its moisture having been removed, decay is impossible." Perhaps the more correct explanation would be that the germs floating in the air were sterilised by the high temperature in the first instance. This experiment, at any rate, and others like it, are of importance in regard to the importation of meat, as it is well-known that cool dry air is much more economically produced than air at the freezing point. This new scientific aid will come opportunely to many an industry, and in these days of international competition, no such assistance can be neglected.—*Indian Agriculturist.*

It appears probable that there will be a wood famine in Darjeeling very shortly, as the Forest Department has decided not to sell less than 50 maunds of firewood to each purchaser. This will, of course, save the Department a good deal of trouble, but it most certainly will entail a considerable amount of hardship on people who have no place wherein to store such a large quantity of firewood. In fact, the price of firewood has gone up already, owing to a "ring" being formed by the contractors.—*Indian Agriculturist.*

THE

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M. MEAUME.

THE "Revue des Eaux et Forêts" for the 10th April opens with a paper by M. Puton, Director of the Nancy Forest School, on the career of M. Meaume, the well known Professor of Law at the School, and who for many years has edited the law notes in the Revue. M. Meaume after an extremely energetic and useful life, died at Neuilly on the 6th March last, aged 74. Whilst a Barrister at Nancy, and Judge suppléant at the Tribunal, he succeeded M. Tocquaine in 1842 as Professor of Law at the Forest School, only four years after the appointment had been created, and at once commenced his Commentary on the French Forest Code, which after 40 years' experience, is still the authority on Forest Law. This was followed by a number of other works ón Forest Law, and finally he shared in bringing out the Code Forestière Annotée in 1884. Many of the readers of the "Indian Forester" will remember M. Meaume's vigorous style of lecturing, which commanded the attention of his hearers, and M. Puton, who succeeded M. Meaume in the professorship in 1873, states that, the latter insisted on his joining the Nancy bar, on the ground that discussion alone can prevent a professor from being too dogmatic.

In questions of Forest Law, both in France and abroad, M. Meaume was constantly consulted, and gave the soundest opinions on the most intricate questions.

A great traveller, M. Meaume was quite at home in Switzerland and the south of France, and in Italy. In general literature, and especially in the history of Lorraine, M. Meaume published numerous works, and his travels in Italy made him a true appreciator of art, and his work on Jacques Callot the sculptor has become classic.

Whilst paying our sincere respects to his memory, we recommend M. Meaume's old pupils in India to read M. Puton's admirable account of his eminently useful life.

FOREST ORGANIZATION FOR BEGINNERS.

(*Continued from page 197*).

SECTION III—ASSESSMENT—(*continued*).

Choice of a Method.

The method of estimating the increment by felling test-trees and measuring their growth is far too laborious and slow to be employed over and over again in each individual case. It should, therefore, be confined, as a general rule, to experiments made for the purpose of constructing tables of growth. In that case, the increase should be ascertained by the sectional method, as it is very different in different parts of a tree, and one measurement at mid-section cannot possibly give as accurate results as are desirable in the preparation of tables. A glance at the tables given in the last number of the 'Forester' will suffice to show how uncertain the increment is, and that it would not do to speculate for lengthy periods on prospective growth as indicated by the past: 20 years may be taken as the outside limit, but 10 years will suffice for most purposes.

For isolated standards and primitive forests, tables showing the rate of growth per cent. may be constructed for trees of various ages and quality-classes, and for a whole district.

When experiential tables are not used, the method of mean yearly growth, or of form-coëfficients may be employed. The former is perhaps the most reliable of all methods at certain stages of a group's existence, but it can only afford thoroughly reliable results for groups which have arrived at an age at which the mean yearly and current increments are pretty equal. This juncture happens exactly when the group has attained its maximum mean yearly growth, and at a time when the current and mean growths remain pretty equal for a long period. The employment of the method implies, therefore, a previous knowledge of the general laws of growth of the species under given conditions. Its extreme simplicity, however, and the absence of all elaborate calculations and difficult measurements, will often recommend its use to the organizer, even though the laws of growth have not been thoroughly investigated, and although the age of the group may be such as to preclude all possibility of the estimate's being correct. In the latter case, allowance may be made for probable deficiencies by adding or deducting, as the case may appear to demand, a certain percentage of the result obtained.

Before leaving this part of the subject, Pressler's gauge for

measuring the basal increment of standing (or felled) trees should perhaps be mentioned.

It consists in a hollow steel cylinder, about $\frac{1}{4}$ inch in diameter, open at both ends, and with the thread of a screw on its outside. If this instrument is driven into a tree, a column of wood ascends the tube, and when it has penetrated sufficiently to reach down to 5-10 years' growth, the cylinder of wood in the tube is clamped to it by inserting from behind a flat pin between the wooden cylinder and the tube ; this can be easily done, owing to the tube's being slightly contracted at its mouth, which causes the column of wood to fit quite loosely at its upper end. The gauge is then unscrewed, bringing with it the cylinder of wood, which breaks off from the tree, near the mouth of the instrument, owing to its having been clamped. The number of annual layers to the inch can then be counted on the piece of wood extracted and the diametral rate of growth, at the particular spot experimented on, calculated.

To find the cubic growth, let M represent the present contents of the tree of diameter D : m its cubic contents n years ago when of diameter d : H and h and f and f' being the corresponding heights and form-coëfficients. We shall then have

$$M = \frac{\pi}{4} D^2 . H . f : \text{ and } m = \frac{\pi}{4} d^2 . h . f'.$$

$\therefore M - m = \frac{\pi}{4} D^2 . H . f - \frac{\pi}{4} d^2 . h . f' =$ the increment during n years.

If tables of coëfficients are not available f and f' cannot be ascertained without felling the tree, and they must, in default of such tables, be assumed as identical. h, too, may have to be taken as equal to H. These assumptions granted, the increment would be equal to

$$\frac{\pi}{4} (D^2 - d^2) H.$$

It is evident that this method rests far too much on uncertain assumptions to be of much value in estimating cubic increment. In the first place, diametral growth varies greatly in different parts of a tree, and the growth in one part is no criterion of that of any other. Secondly, the coëfficient is also known to be variable ; and, thirdly, the height-increment is a factor which ought to be taken into consideration. The principal use of Pressler's gauge will, therefore, generally be for testing the diametral increment in order to find out roughly when a tree will become of sufficient bulk to be useful for some special purpose, such as for conversion into railway-sleepers. In such cases, it may prove very serviceable and a means of preventing fellings. It is usual to stop up with clay the hole in the tree made by boring, in order to exclude air and prevent rot.

(7). Determination of the Age of Groups.

It is necessary to know the age of a group, or at all events of its oldest age-classes, in order to determine the most advantageous revolution, or the number of years required to produce a certain quantity, or quality, of wood under given conditions. For series subject to the method of regular cuttings (*see* p. 3) *the average age of a group must be known approximately if we* are to know to what period it belongs naturally. A knowledge of the age of groups may, further, be necessary, as we have just seen, in order to determine the increment. It is, however, of little or no immediate importance in the case of groups which, on account of their advanced age, inferior growth, or any other reason, must undoubtedly be felled during the current period.

It is seldom that the trees of a seedling-group which has been naturally regenerated are all of about the same age. Such uniformity is likely to be found only in coppice, and in seedling-groups which have been planted. *When a group is practically* uniform, it will suffice to fell and count the annual layers of one of the larger trees (large layers being more easily counted than small ones). Sometimes a record may have been kept of the age of a group, when, of course, no fellings will be necessary, and in some species the age can sometimes be told with sufficient accuracy by the number of branch-whorls. In counting the annual layers, allowance has to be made for the length of the stump. Before counting the layers, it is generally necessary to smooth the surface of the wood with a plane. If the *layers do not even then stand out distinctly, an application of* very dilute ink, or other coloured liquid, such as a solution of starch, chloride of iron, &c., in addition to the use of a magnifying glass, may have the desired effect. The rings are counted in tens. As soon as ten have been counted, they are marked off with a pencil, the next ten are treated in the same way, and so on until the whole number are echeloned from centre to circumference. By this means, mistakes of addition are easily avoided, and, if a mistake is made, it is not necessary to begin again from the beginning.

In considering the case of an irregular group, it must be borne in mind that the question to be answered is, what the age of a regular group under the same conditions would be if its cubic contents were equal to the contents of the group under examination. If Draudt's method for fixing the relative number and the sizes of the test-trees be employed, the average age in the above sense would be obtained by counting the annual layers of all test-trees and dividing their sum by the number of such trees. By this method the calculation of contents is entirely avoided.

But if Draudt's method be not employed, it is necessary in order to obtain thoroughly satisfactory results, to calculate the

cubic contents of a group according to age-classes. If A is the average age of a group, M its volume, I its increment, the mean yearly increment will evidently be found by the equation

$$I = \frac{M}{A}$$

from which we get

$$A = \frac{M}{I}$$

Supposing, now, that a group consists of a number of age-classes, with cubic contents m_1, m_2, m_3, &c., and ages a_1, a_2, a_3, &c., respectively. The mean increment of each age-class will then be $\frac{m_1}{a_1}, \frac{m_2}{a_2}, \frac{m_3}{a_3}$, &c., and their sum will represent the mean annual growth of the whole group. Substituting these values in the formula $A = \frac{M}{I}$ we get

$$A = \frac{m_1 + m_2 + m_3 + \&c.}{\frac{m_1}{a_1} + \frac{m_2}{a_2} + \frac{m_3}{a_3} + \&c.}$$

Take, for example, a group of 430 trees, with four age-classes, and constituted as follows :—

Diameter Class, inches.	No. of trees.	Cubic contents of whole, cubic feet.	Age, years.
20—22	150	4,800	60
22—24	100	6,400	68
24—26	100	9,000	76
28—30	80	8,900	85

The mean growth for each class will then be

For the class 20-22 inches, $\frac{4800}{60} = 80$ cubic feet.
" 22-24 " $\frac{6400}{68} = 94{\cdot}12$ "
" 24-26 " $\frac{9000}{76} = 118{\cdot}42$ "
" 26-28 " $\frac{8900}{85} = 104{\cdot}24$ "

The average age of the whole group will, therefore, be

$$\frac{4800 + 6400 + 9000 + 8900}{80 + 94{\cdot}12 + 118{\cdot}42 + 104{\cdot}24} = 73 \text{ years.}$$

8. The Station.

Under this heading, the climate, soil and situation of compartments has to be considered. A knowledge of the station may be useful to the organizer in many ways. It is a guide to the rate of growth which may be expected : it enables him to

select the most suitable species for regeneration, and the best revolution and treatment for groups.

1. *Climate.*

This will be tolerably uniform for all compartments of a range, and need not be repeated for each one. It is usual to describe the general climatic conditions, once for all, in the introduction which invariably prefaces the document, or report, describing and justifying the proposed organization-scheme. Special climatic conditions should, however, be noted for each group. For instance, the general climate of a tract may be very raw, but certain portions may be comparatively mild owing to a sheltering hill. Extremes of temperature, occurrence and duration of moisture-laden winds (monsoons) or dry winds; the direction generally taken by violent storms; the average rainfall; height above the sea; are the most important points to note in regard to general climatic conditions.

2. *Soil.*

The kind of underlying rock may be noted (gneiss, limestone, &c.), depth and kind of soil (clay, sand, &c., and their modifications), degree of stiffness (stiff clay, heavy loam, light loam, &c.); degree of moisture. Other physical properties, such as colour, power of absorption, permeability, may also be noted.

Surface-growths, not forming part of the forest (such as moss, grasses, ferns) are often important indicators of the quality and degree of moisture of the soil, and its suitability to certain species.

3. *Situation.*

The chief points to note are—the aspect (whether north, south, east, or west); whether the site is exposed, or sheltered; in very hilly country, the angle of the slope may be given, approximately. These data should be given for each compartment separately.

Classification of the Station.

In classifying stations, it is usual to distinguish three, or more classes, and, as the quality of a station depends to a certain extent on the species for which it is intended, the same classification will not do for all species; each one must be dealt with separately. This precaution is obviously necessary, as a first-rate station for one species, may be the worst possible for another. As a rule, the quality of a station is only given for the principal species found growing on, or near, the spot referred

to. When no forest exists in the vicinity, as may happen in the case of large wastes, it is generally of slight importance to classify the station: all the information really required then, is a note giving the species which appear best suited to the station; afterwards, when the area has been stocked, and the young growth is coming on, it will be quite soon enough to proceed to a classification.

A good way of expressing the quality of stations is to make the best the unit of comparison, representing it by unity, and the qualities of others by decimals of one. The quality of a compartment stocked with Xylia and teak might, for instance, be described as ·8 for Xylia and ·5 for teak. The difficulty is how to determine those values. It is not possible to gauge separately the three factors which together make up the station; to say how much of the effect is due to soil, how much to situation and how much to climate. The best station is naturally that which, other things being equal, produces in a given time the greatest quantity of wood; or, as there seems to be a decided relation between the quantity of wood produced and the average height of a group, that station whose group shows a greater average height than that of another of the same age and species will be the better of the two. Thus, collectively, the value of the three forces may be measured numerically by the number of cubic feet produced, or by the average height attained, by a group during a given period. Experiential tables may, therefore, be advantageously employed for this purpose, whenever circumstances admit. How such tables may be prepared and used, has been already fully explained (*see* page 94), and need not be alluded to further. Unfortunately, they can only be usefully employed in the case of tolerably regular groups. For irregular groups, Grebe recommends that regular, well-stocked groups of various ages and qualities should be selected as representative of their respective classes, their stations compared with those of irregular groups, and the quality-classes of the latter determined accordingly. How this comparison is to be effected unless the groups to be compared happen to be close together, it is difficult to say. Even then, it is not easy to understand how the stations of well-stocked groups can be compared with those of badly-stocked groups, as the appearances of two equally good stations would certainly be very different under the circumstances.

Perhaps there is a tendency to exaggerate the importance of attempting to give exact numerical values for the quality of the station. In olden days, it was the fashion—a fashion which has not even yet quite died out—to estimate the yield of every group at the end of its proposed revolution, which often involved the calculation of increment for a couple of hundred years or so: in such cases, it was a matter of importance to fix the quality of the station with great accuracy, especially for young groups subject to long revolutions. Now-a-days, however, things are a

good deal changed and simplified, and modern methods of calculating the yield seldom require an estimate of increment exceeding 20 years. For most practical purposes, therefore, it ought to suffice to estimate the value of the station roughly by eye for 3-5 classes. Any short-comings in this estimate may be fully compensated by increased care in the examination of the present contents and increment of standing-stock (*i.e.*, *of the quality-classes of groups) on which the yield of the forest* more immediately depends.

The results of the examination of the station are recorded in the register of compartments, a sample of which was given at page 2.

(*To be continued*).

PORTABLE FOREST TRAMWAYS, AS USED IN FRANCE AND GERMANY.

By D. BRANDIS, *late Inspector General of Forests, and* MAJOR F. BAILEY, R.E., *Conservator of the School Forests.*

THE Decauville portable tramway was invented in 1876, by a French gentleman of that name, for use in his business; but he very soon began to manufacture the rails and trucks for sale. He exhibited his invention at various agricultural and other shows in France and also in Belgium and Norway, obtaining gold medals and other prizes. In 1877 the tramway was shown in England and Ireland, and as orders began to come in rapidly he was obliged in January 1878 to increase the number of men employed upon its manufacture from 35 to 100. Since then the development of the use of the tramway has been extraordinarily rapid, and the number of workmen employed by M. Decauville had, by the middle of 1884, risen to the large number of 900, a railway station on the Paris-Lyons railway having been built near the works. Between 1878 and 1884 the invention was exhibited in Austria, Italy, Buenos Ayres, Calcutta and Japan, orders having been received from the Russian Government who required the tramway for use in Turkestan, from the French Government for use in Tunis, from England and Australia and many other countries. It is at the present time, almost without doubt, the largest establishment of the kind in the world.

For forest purposes tramways have not, however, as yet come into general use in France. A brief account of one established on the outer spurs of the Vosges by M. Michaud, will be found on page 490 of the "Revue des Eaux et Forêts" for 1883. In Germany portable tramways for the carriage of timber have lately attracted general attention, and it is hoped that their employ-

ment on a large scale will diminish the cost of timber carriage, and will have the effect of increasing the money yield of forest property which is very low at the present time. As long ago as 1879, Forstmeister Sprengel, who is in charge of the Forest district Kottenforst near Bonn, proposed to lay down such a line through that district, to be used partly in the working of the forest, partly to supply a large private dairy farm, situated on the edge of it, with fodder for its cattle, the cost of the undertaking being shared by the proprietor of the farm with Government. At that time tramways for forest purposes had not yet attracted much attention, their advantages were not believed in, and under these circumstances the plans and estimates submitted by Forstmeister Sprengel remained in the pigeon holes of Government. It is different now, forest tramways are the order of the day in Prussia. A project which Forstmeister Sprengel submitted a few months ago to lay down a portable tramway in the Kottenforst at the sole expense of Government was sanctioned immediately, no severe frost fortunately occurred to interrupt the earthwork, and the line was laid down within three weeks from the day it had been ordered. The line is fully employed, and two Forest officers from India, Mr. Gamble and Major Bailey, the latter accompanied by two of the English forest students from Nancy, have had the privilege of visiting it.

In an article upon Forest Tramways in the September (1885) number of the "Allgemeine Forst und Jagd Zeitung" Forstmeister Sprengel gives an account of his previous project, and dwells with just pride upon the changes which have taken place during the last six years in the views of German Forest officers on the subject of forest tramways.

That portion of the Kottenforst where the tramway* has been laid, occupies a flat plateau on the left side of the Rhine, elevated about 350 feet above the valley. A railway, constructed four years ago, passes through the western portion of the main block, and a station is actually in the forest. Hitherto the timber has been sold where it was cut in the forest, but for its export other stations, situated in the Rhine valley outside the forest, were chiefly used, as it was convenient to carry the timber down hill. *The intention now is to establish a large timber* depôt at the forest station, and to hold the principal timber sales at that place. In order to feed the depôt at that point the main lines of the forest tramway has been laid down along side a metalled forest road for 6·2 kilometres (4 miles) in an easterly direction, and the portable side branches, which at present aggregate 2 kilometres ($1\frac{1}{4}$ miles), will be joined on to the main line on both sides and from the two ends in all directions, so as

* The rails of the tramway laid down weighed :—
Those of the permanent line 5 kilo. per running metre.
Those of the moveable line 7·2 kilo. " "
The rails are of Bessemer steel, and were supplied, with the whole tramway and rolling stock, by R. Dolberg, Rostock.

to carry the timber cut over an area of 2,400 hectares (5,938 acres). The total area of the Kottenforst is 3,521 hectares (8,700 acres), of which 3,439 hectares are stocked with forest (holz boden), and the total annual yield of all descriptions of wood amounts to 14,947 cubic metres (528,000 cubic feet), which corresponds to an annual yield of 4·34 cubic metres per hectare, or 62 cubic feet per acre. The area which will be served by the tramway, will yield annually about 10,416 cubic metres, and of this quantity there will be about 2,600 cubic metres of large timber, all of which will be carried by the tramway. Of the small wood a portion will probably continue to be carried by carts, but a quantity, of which an estimate cannot yet be framed, will also be exported by the tramway.

The greater part of the Kottenforst was formerly coppice under standards, consisting originally of oak, beech and hornbeam. Clearances and blanks had been planted up with Scotch fir chiefly between 1820 and 1840, and with spruce, with a little larch and silver fir, planted mainly about 1860. Some groves and rows of fine larch trees standing near the main line of the tramway were planted in 1810, in honor of the birthday of the Emperor Napoleon, who then ruled over this part of Germany. The coppice under standards is in process of conversion into high forest, and over a large portion of the forest the conversion has been completed. In the south-east corner some compartments are stocked with old high forest of beech and oak, and adjoining these there is a considerable area, which was formerly pasture land with oak trees, mostly planted, and standing about 15 feet apart. Of this kind of pasture land under oak trees, which in North Germany is well known under the name of *Hutweiden*, a much larger area in this place was formerly the property of Government, but burdened with extensive rights of pasture held by the inhabitants of the surrounding villages. About 20 years ago these rights were commuted, the area of this pasture land under oak trees being divided between Government and the right-holders. Thus the Government now holds a smaller area free of rights, which through good protection has gradually become stocked with thickets of young oak, the old trees being gradually cut out. On the 24th of February we witnessed the removal of logs from this part of the forest, while a fortnight earlier we had seen the timber work in the midst of the compartments in process of conversion from coppice under standard to high forest. Of the large timber cut in the Kottenforst nearly one-half is oak, but the demand has fallen off and prices have gone down considerably of late years. In 1884-85 the rates paid for oak timber were, as stated by Forstmeister Sprengel in the article quoted: for first class timber 50·25 Mark, and for fifth class timber 20·65 Mark per cubic metre. By employing the tramway and by selling the timber at the railway station, it is expected that much better

prices will be realized. This, however, is not the only advantage anticipated from this measure. Of late years the demand has often been so slack, that the timber used to remain two or three years, or even longer, lying in the forest, before it could be sold. With the aid of the tramway it will be exported a few months after it is cut, in March and April, and thus the forest will be cleared out sooner, and the young growth will be much less disturbed.

Two portable forest tramways have already, we understand, been laid down in the Nellore district of the Madras Presidency, and others have probably ere this been established at other places. We assume that the construction of such tramways is generally well understood in India, and that it will suffice to mention a few points relating to the one we have mentioned. The gauge is 0·60 metre, or about 2 feet. The ground is almost level, here and there with very slight undulations. The main line may for the present be regarded as permanent, the position of the branches being changed from time to time to follow the progress of the cuttings. The main line is laid in lengths or sections of 7 metres, on sleepers of wood or iron. The rails, both of the main line and the branches, are of steel, their weight is between 6 and 8 kilogramme per running metre. The sleepers are at one metre apart, and the rails are rivetted into the iron or spiked down into the wood. The seventh sleeper supports the joint. The sleepers are laid in ballast at the side of the central metalled portion of the road. The joints are made with fish-plates.

The branch lines are laid upon the natural surface of the ground, which is not levelled in any way. They consist of sections 2 metres long supported at each end by a wooden sleeper. These sections weigh 38 kilogrammes (84 lbs.), and are, therefore, easily carried by one man. In the system here used the sleepers of the branch lines are always made of wood, which from its greater rigidity is found to be more suitable than iron for laying upon an uneven surface. The sleepers being nearly 2 metres apart, the rails used are stouter, and they weigh about 8 kilogrammes per running metre. There is sufficient play in the joint to admit the line being curved to some extent, in order to avoid stumps of trees and other obstacles. For greater curves spinal sections with curved rails are used. The essence of this arrangement is, that the branch line is brought alongside of the logs as they lie, and that the logs are loaded upon the trucks without having to be previously moved from the place where they fell. This of course leads to the line being carried over broken ground, small ditches and pools of water. In such cases the sleepers are supported by rough pieces of wood or turf, hastily laid. In this manner 2 kilometres of branch line were laid in two days by two men, and trains of heavily laden trucks pass over it without accident. One kind of truck serves for the carriage of material of all kinds.

When used for the carriage of logs a horizontal revolving plate is fixed on the top, furnished either with an iron crescent-shaped support or a horizontal bed on which the ends of the log rest between moveable vertical arms. The revolving plates admit of a pair of trucks with the log loaded upon them being taken round curves.

For lifting the logs on to the trucks, numerous devices have been invented. The two in use in the Kottenforst, consist of a double crane, which raises up the log vertically, and an inclined plane, up which it is rolled.

The crane, which is capable of lifting 9,900 lbs., is placed astride the log. It consists of two uprights joined at the top by a moveable pin. The uprights are made of wood, strengthened with iron, and they are hinged into horizontal pieces, which rest upon the ground. The log which has been previously rolled on to the rails, is gripped by a pair of powerful iron pincers, and is then raised by chains and pulleys worked by two hand levers. By this apparatus logs of considerable size are easily raised to the required height by two men, working at the two levers. The log having been raised high enough to clear the top of the truck ($2\frac{1}{2}$—3 feet) the two trucks are passed underneath, and the log is gently lowered upon them. It is then secured by chains terminating in conveniently shaped wedges which are driven into the log to make all fast. An oak log measuring about 36 cubic feet was raised upon the trucks and secured in four minutes. Each half of the apparatus is easily carried by one man.

The inclined plane is formed by two bars or beams built of iron and wood, resting partly on the ground and partly on the truck. To each beam is attached a chain which is passed round the log and over a wheel, and the chains are then hauled in by means of hand levers similar to those used with the crane previously described. The log is thus rolled up over the trucks, when the beams are removed and the log is allowed to lie between the rests on the revolving plates. This arrangement is regarded as safer for the workmen than the crane.

A third arrangement, which from its easy construction may perhaps be more suitable for work in India, but which is not in use in the Kottenforst, consists of a tripod. From the apex a set of pulleys is suspended, by means of which the log is raised.

When a sufficient number of logs have been loaded up, the trucks are coupled together, a coupling pole being put in when the logs project, so that the ordinary chains and hooks are too short. The horse is attached by a chain to the last truck, so that the driver is able to see the whole train before him. It is said that on level ground one horse will draw a train loaded with about five tons of timber. The short train on which we travelled, was formed of three pairs of trucks with logs aggregating about

110 cubic feet of oak timber, and it was dragged along on the main line at a sharp trot without slacking speed at the curves, not the slightest difficulty being experienced. The trucks are provided with brakes to be used in case of necessity.

In order to carry fuel, a platform about 12 feet long and 4 feet wide, is laid on a pair of trucks. When earth or gravel has to be carried, an ingeniously arranged tip cart is substituted for the platform.

The cost of the whole line laid down, including rolling stock and all apparatus, was 25,000 Marks paid to the manufacturer, plus 800 Marks expended on the earthwork for the main line. This corresponds to an average cost of £252 per running mile, and it is estimated that the plant will last 15 years.

As already mentioned, Forstmeister Sprengel hopes that it will be possible to export all the heavy timber, felled during the winter months, in 2½ months of the spring, by means of two horses with a driver each, and eight men to lay the branch lines and to do the loading and unloading. It is expected that a horse will carry 20 cubic metres (200 cubic feet) per diem, so that in 65 working days the whole quantity of timber to be exported during the year, *viz.*, 2,600 cubic metres, will be carried.

During the remainder of the year he expects to find sufficient employment for the tramway by carrying fuel and other small wood for purchasers, by carrying gravel and other material for keeping in repair the forest roads, aggregating about 27 kilometres, and by permitting the tramway to be used by the villages adjoining the forest, where there are large potteries and some other industries.

The question which will naturally present itself to the readers of this journal is, in what localities portable forest tramways, similar to that here described, may be usefully established in India.

On hilly ground many of the advantages of the system are lost, and its use will at first probably be confined mainly to localities with level or slightly undulating ground. But by employing powerful brakes timber trains may be brought down fairly steep inclines, so that the employment of the system on hilly ground is not excluded.

The sál forests of Oudh, and of the sub-Himalayan tract outside the hills, as well as the level portions of the Dehra Dún and Patli Dún will probably be found suitable. By means of forest tramways it will likewise be found possible to facilitate the working of the teak forests of Ahiri, of some of the teak forests at the foot of the hills in Pegu, and probably of a large extent of teak forests in Upper Burma. The bija-sál forests of Mohurli, the babul forests of Sind, and the large plantations in the plains of the Punjab, such as Changa Manga, may likewise be mentioned as instances.

In nearly all these cases there will be deep ravines which the main line will necessarily have to cross. For this purpose bridges will be unavoidable. As a rule it will probably be best to build them of the timber available in the forest. In the construction of branch lines the necessity for larger bridges must be avoided.

It now remains to mention the chief manufactories of forest tramways and the necessary apparatus on the Continent.

In France the principal establishment is that already mentioned, by Decauville ainé at Petit Bourg (Seine et Oise) 55 minutes by train from Paris. The illustrated catalogue published by him gives all needful information regarding his inventions.

In Germany the three chief manufactories are :—

1. Georgs-Marien-Bergwerks und Hüttenverein, Osnabrück.
2. R. Dolberg, Rostock.
3. Spalding, Jahnkow, Pommern.

At the Calcutta Exhibition of 1884 six English firms exhibited portable tramways, their names and addresses can doubtless be ascertained from the catalogue.

Of the numerous publications on the subject the following may be mentioned :—

1. Schubarth, die Feldeisenbahnen im Dienste der Waldwirthschaft, Berlin, A. Seydel, 1884.
2. Von Baumbach, über die Verwendung der transportablen Eisenbahnen in den Königlichen Forsten. Zeitschrift für Forst-und Jagd wesen, 1885, p. 192.
3. Adolf Runnebaum, die Waldeisenbahnen, Berlin, Julius Springer, 1886.

INDIAN FORESTRY.*

THE area of the forests of India has been diminished by the growing demands for land from a rapidly increasing population, and also to meet the wants of advancing civilization. Such legitimate requirements, however, might have been counterbalanced by the sowing and planting of the husbandman, aided by Nature; but, until recent years, the people had been reckless in their cutting; the migratory forest tribes had been burning the forests in order to obtain a clearing for their Coomrie, or virgin cultivation; the pastoral tribes added to the accidental fires by burning off the old grass in order to allow young herbage to spring up for their flocks; while the goats

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* By Surgeon-General Edward Balfour, Author of "The Timber Trees of India," The Cyclopædia of India," &c., &c. Reprinted from the "Journal of the National Indian Association" for October, 1885.

and sheep, horned cattle and camels, eat off the tops of the sprouting seedlings. It has fallen to the British Government to put a stop to these injuries.

There is a consensus of opinion among scientists that vegetation purifies the air and the water; that trees condense the moisture of the atmosphere; shelter the soil from the scorching heat of the sun's rays and from arid winds; check evaporation; regulate the moisture in the ground; and retard the flow of the falling rain. Also, that there has been in India an increasing aridity and temperature consequent on forest clearings, and that the prices of timber and of fuel wood have been rising everywhere, in many places even have doubled. Among the eminent men of Europe who had given early attention to this subject may be named St. Pierre, Dr. Priestley, Humboldt, and Boussingault; and in India Dr. Gibson and Mr. Dalzell have been conspicuous. St. Pierre's views were founded on what he had seen in Bourbon and the Mauritius, and he was *strongly in favour of the protection of tropical forests.* Humboldt's experience was acquired in South America. Writing at the opening of the nineteenth century (*Personal Narrative*, iv., 143), he told the world that "by felling the trees that cover the tops and sides of the mountains, men in every climate prepare at once two calamities for future generations: the want of fuel and a scarcity of water. That when forests are cut down (as they are everywhere in America by the European Planters, with an imprudent precipitation) the springs are entirely dried up or become less abundant; the beds of the rivers, remaining dry during part of the year, are converted into torrents whenever great rains fall on the heights; the sward and moss disappearing with the brushwood from the sides of the mountains, the waters falling in rain are no longer impeded in their course; and, instead of slowly augmenting the level of the rivers by progressive filtration, they furrow, during heavy showers, the sides of the hills, bear down the loosened soil, and form those sudden inundations that devastate the country. Hence it results that the destruction of forests, the want of permanent springs, and the existence of torrents, are three phenomena closely connected together." Subsequent to the promulgation of these views South America was twice visited by M. Boussingault, at long intervals. He witnessed the effects of denuding a district of its foliage and of again reclothing it, and he corroborated all that Humboldt had written. He tells us (*Jameson's Edinburgh Philosophical Journal*, 1839) that "in the valley of Aragua, when the process of clearing was pushed farther and farther, and when cultivation in every shape was advancing, the level of the water gradually subsided. More lately, on the contrary, during a period of misfortune, . . . when the clearing was no longer continued and the cultivated lands had fallen back into their wild state, the waters

have ceased to fall, and are now very speedily assuming a decided rising movement."

It was at this time that the condition of the forests of India began to receive State attention. The exhausting demands for fuel for the Porto Novo works had shown that iron manufacture on a large scale could not be carried on, merely trusting to Nature to restore the woods, and from the first days of the appointment of Dr. Gibson (1837) and Mr. Dalzell (1840) to the care of the forests of the Western Presidency and Sind, these officers unceasingly urged on the authorities the necessity for protecting the existing forests and for replanting denuded tracts, and they pointed to many tracts which had been injured by reckless felling. The Directors of the East India Company seem to have had their attention drawn to the subject by Dr. Gibson's writings, and in a despatch of 7th July, 1847, they requested the Governor-General to ascertain "the effect of trees on the climate and productiveness of a country, and the results of extensive clearances of timber." Information was accordingly called for from Government officials, and many of the Madras Revenue Officers reported on it, but the only communications that were published consisted of a reprint of a paper which Assistant-Surgeon (now Surgeon-General) Balfour had written in 1840, and letters by Major-General Cullen and Surgeon C. I. Smith. Thirty years later, in 1878, the India Office printed a second pamphlet by Surgeon-General Balfour, reviewing the information acquired on the subject in the intervening period. This included returns as to Rainfall and Famines; Writings of Mr. Innes, of Phil-Indus, of Sir Richard Temple, M. Fautrat, and Robert Wight. The last named, an eminent botanist, was for many years employed superintending the cotton-growing experiments in Coimbatore, and when writing in 1850, he took occasion to commend the resolution of the Madras Government to plant trees on a large scale in order to shelter the land from scorching winds. He then advised the planting of a variety of trees; recommended those with large heads, and growing rapidly, as likely to produce the speediest effect on the climate, but at the same time he pointed to the best timber trees and best fuel trees as economically the most valuable. Since then, as another means of watching over the atmospheric phenomena which foreshadow storms and droughts and famines, the Government of India, ten years ago, established a Meteorological Department, under Mr. Blanford, an able scientist, who has already given useful information. Ever since the middle of the nineteenth century the several Governments of India have thus been bestowing an increasing attention on the forests within their respective jurisdictions, and the latest information available tells us that in the year 1883-84 there were 49,850 square miles of State forest demarcated and reserved in India, as compared with 12,071 square miles in 1874-75. Of

this reserved area 19,430 square miles are in the Central Provinces, 9,397 in Bombay, 4,635 in Bengal, 3,758 in British Burma, 3,380 in the North-West Provinces and Oudh, 2,869 in Madras, 2,314 in Assam, 1,635 in Berar, and 1,398 in the Punjab. Doubtless, 49,850 square miles of forest land is a great area; but the area of British India is 1,477,763 square miles, and centuries of neglect and of reckless felling have so denuded great tracts, that a writer in *Macmillan's Magazine* (January, 1878, p. 253), under the pseudonym of Phil-Indus, estimated that in 1874-75 an area of about 80,000 square miles required to be replanted.

For the care of its forests, the Indian Governments employ nearly 400 European and Native Conservators and Rangers, at an annual cost of £239,484. Hitherto the forest officers sent from Europe have had to study their profession in France or Germany, but a School of Forestry has been opened at Dehra, on the southern slopes of the Himalaya, and arrangements are now in progress to establish a similar school in connection with the Engineering College at Cooper's Hill. Forestry in India is already a large department, although its first commencement was in the year 1837, by the appointment of Dr. Gibson to be Superintendent of Forests in the Bombay Presidency, followed in the Madras Presidency about the years 1848 and 1856, by the employment, successively, of Lieutenant Michael and Dr. Hugh Cleghorn; and on the latter officer being subsequently transferred to the Punjab, Colonel Beddome succeeded him in Madras. About the year 1856 Dr. Brandis had been nominated to the care of the Burma forests, but in 1862 he was gazetted Inspector-General of Forests under the Government of India, and about the same time Mr. Dalzell, from Sind, succeeded Dr. Gibson in Bombay.

There has been nothing like all this watchful care over the forests of Great Britain. Indeed, during Her Majesty's reign several of the Royal forests have been disafforested, although, formerly, in England and Scotland there were nearly a hundred of them. Britain, in ancient times, had its Forest Laws, many of them severe, and some even sanguinary, and the existing regulations will doubtless be scrutinized by the Committees of the House of Commons, the first of which assembled under Sir John Lubbock as chairman. It may be feared that the Committees will discover many encroachments, a general ignorance of Forestry, and much neglect. These have arisen in various ways. Owing to the abundance of coal, the British forests as a source of fuel have not been required; its insular position has admitted of timber for all constructive purposes being largely imported; even its land proprietors are only now waking up to the consciousness that in their neglect of Forestry they have been overlooking a considerable source of income, and so, just at the close of the last Session, Sir John Lubbock obtained the

nomination of a Committee of the House of Commons "to consider whether, by the establishment of a forest school, or otherwise, our woodlands could be rendered more remunerative."

Indian Forestry has taken a wider view than this of its duties; its chief aims have been to protect and enlarge the natural forests of the country; to sow the more valuable plants, and to protect the clothing of the mountain heights and glens where rivers spring. Difficulty is only met with in replanting on the bared plateau of the Central Dekhan. There the cultivators rely almost solely on their winter crops of wheat, cotton, maize, and pulse, and they cut down every tree and shrub to allow the wintry sun to fall with full force on the growing plants, which find their moisture in the soil and in the fogs and dews of that season. During the past twenty years several writers have been suggesting to English landholders the desirableness of having timber plantations on their estates, but the want of reliable information has been hindering action. Already, at the first few sittings of the Committee, information had to be sought for from persons with Indian experience, and Colonel Michael, C.S.I., one of its earliest employés; Dr. Cleghorn, the first Madras Conservator; and Mr. Pedder, of the Revenue Department of the India Office, have been under examination. But Forestry has been a State necessity in all the kingdoms of Continental Europe, and India has availed itself of the knowledge of the science possessed by other than British subjects. Dr. Brandis, for instance, a former head of the Forest Department, and Dr. Schlich, its present chief, are, both of them, of other nationalities. The Indian Conservators have been remarkably free from illness. The malarious atmosphere in the forested mountain passes and in some of the forests on the plains had earned for them the most evil fame. Nevertheless, all but two of the Conservators have passed unscathed through the sickly atmosphere, and they have all left their mark.* Dr. Gibson, between 1837 and 1846, unceasingly advised the Bombay Government both to protect and replant, warning the Government that denudation had already led to the drying up of springs and to diminished moisture in the soil, on which, in tropical countries, so much depends; he showed that timbers and fuel had greatly increased in price, and he particularly commended planting the thorny babul trees on all the bared and arid sites. Several of his Reports were printed, also his *Handbook of Indian Forestry*, and he and his successor, Mr. Dalzell, were joint authors of *Dalzell's Bombay Flora*.

Dr. Cleghorn's tours of administrative duty in Madras and the Punjab were noteworthy for his valuable suggestions as to

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* This is not quite correct; although men of marked physical and constitutional strength have been selected as Conservators, several of them, and notably Mr. Brandis, have suffered severely from the hard work and exposure.—[ED.]

the protection of seedlings and growing timber, for the most economic modes of felling and for removing logs from the forests. He strongly denounced the Coomree, or virgin soil cultivation of the migratory forest races, as also the herdsmen's practice of firing the jungle to obtain young grass; and he remonstrated with the Public Works Department on felling valuable timbers for purposes for which the wood of very ordinary trees was sufficiently serviceable. His periodical reports, his book on *The Forests and Gardens of Southern India*, and his Report on the Punjab Himalaya contain much useful information. Dr. Brandis, whilst in Burma, printed a catalogue of the timbers which he had sent to the Exhibition of 1862, and when he became Inspector-General of Forests, his efforts were directed to obtaining for the Department a legal status. He originated the three Forest Acts still in force; *viz.*,—No. VII. of 1878, applicable to India generally, including Bombay; No. XIX. of 1881, relating to British Burma; and No. V. of 1882, for Madras. Under this legislation the forests are classed (1) as Reserved Forests; (2), Protected and Village Forests; (3), Forests which are private property. It was on his recommendation that a School of Forestry was opened at Dehra, and in his time Mr. Kurz's book on *The Flora of Burma*, and Mr. Gamble's *Timber Trees of India*, appeared. Mr. Dalzell's principal literary labours consisted of his annual reports, but jointly with Dr. Gibson he wrote, also, his *Bombay Flora*. Colonel Beddome's tour of administration in Madras was eminently literary, as his *Flora Sylvatica* and his works on Ferns and Snakes testify. Ceylon has been equally progressive, and though not politically forming part of British India, it may be mentioned, as it has a Forest Department of its own, and its Flora and Timber Trees have been well described by Dr. Thwaites and Mr. Fergusson. In climate and flora it assimilates with the Peninsula.

It will be seen from these remarks that the Indian Governments have been well served by their forest officers, who have shown themselves to possess much literary and scientific ability; and the time has come for them to do something more for their department. It is 50 years since Indian Forestry had a beginning, in the nomination of Dr. Gibson to the superintendence of the Bombay forests, and there is now needed from them one book bringing their knowledge of the forests and their trees up to the present time, and another as a handbook of Indian Forestry, arranged in parts, to admit of the regions of British India being worthily described. The information in Drs. Stewart and Cleghorn's works on the trees of the Punjab Himalaya; in Stewart and Brandis' *Forest Flora of N.-W. and Central India;* in Mr. Kurz's volumes on the trees of Burma; in Mr. Gamble's *Trees of India;* in the third edition of Surgeon-General Balfour's *Timber Trees of India and of Eastern and Southern Asia;* and in Colonel Beddome's *Flora Sylvatica*, need all to be brought

together in compact volumes. The financial results from establishing a Forest Department in India justify liberality in making its trees and forests better known. Its revenue has been continuously on the increase. Twenty years ago, in 1867-68, the gross receipts were stated at £334,000, but in 1883-84 they amounted to £1,052,190, and the clear profit in that year was £403,815. A general and a detailed statement of the 1883-84 receipts and expenditure are subjoined.

Already, the evidence given before Sir John Lubbock's Committee has furnished valuable information on many points. Mr. Pedder (116) says: "The destruction of forests was undoubtedly seriously affecting the water supply in many parts of the country, and seriously affecting the climate." He adds (118): "There are, no doubt, many instances in which it has been strongly suspected that the diminution of the water supply of the streams has been caused by the cutting down of forests." He says (123): Ratnagiri, a rice district, lies between the sea and the western ghats, and up to the early years of the nineteenth century was so covered by dense forests, that the officers of the Trigonometrical Survey, "in some cases, had to cut a base line at the rate of half a mile a day, for miles through dense forest—whereas now the same district has been almost entirely denuded up to the crests of the hills. The hills are now almost a bare sheet of rock; and people have complained, and complained bitterly, of the decreasing yield of the rice land below, which has been attributed, and I believe truly, to the destruction of the forests, which operates, of course, to prevent the water being stored up on the hill-sides; it runs away in violent floods instead of flowing gently over the country." He further mentions (121) that "in the north of the Punjab it has been represented by men whose opinions are of very great weight, that the denudation of some of the Himalaya forests has caused great destruction, from the way in which the torrents have washed immense masses of sand and stone from the mountains into the plain."

Colonel Michael, in his evidence, says: "My own idea is that wherever you introduce a forest, or wherever you have a forest, the rainfall is more equable; it does not come so much in fits and starts." He mentioned that he had "seen a well-known perennial stream dried up completely, upon the slopes of the Nilgiris, undoubtedly from the fact that the timber all around it had been cut for coffee planting. I can quote a particular spring near the church at Ootacamund, from which most people got their drinking water. Within my memory the wood which surrounded that spring was cut down, the result being that the spring has disappeared, and there is no water there now. I can mention many instances of springs being lost from a forest being cut away."

On this point Mr. Thiselton Dyer says (611): "One cause of the unhealthiness of Cyprus is that by the cutting away of

the woods, and the munching off of the young shoots by the unrestricted feeding of goats upon the northern hills, every drop of water passes to the plain; the consequence is that this Messaria plain in the middle is much more swampy and malarious than it was when the island was flourishing in classical, and even in the middle ages." He adds (612): "A great deal can be done in preserving the remnants of forests; but to replant a mountain range which has lost its arboreal covering is an exceedingly costly thing to do, and a difficult thing to do; all that can be done is, to preserve the remnants from going from bad to worse."

Great Britain may take lessons from India and do much more than it has hitherto done, and ample information has been collected to serve as a guide in further action. There is an Agricultural College at Cirencester; an Agricultural Society and Horticultural Museum in London. Edinburgh, in 1884, held the first International Exhibition of Forestry which Great Britain has witnessed, and several of the exhibitors have this year been examining well-known woods and plantations, while for literature an ample foundation has been laid in the journals of those societies, in the writings of Mr. J. C. Brown and Mr. James Brown, and in the many invaluable reports and books by Miss Ormerod. The British Government will, no doubt, in time, take up this subject, and other Colleges of Agriculture may, within the next decade, be established; but, in the mean time, the county town of every part of Great Britain should have its own agricultural museum, with samples of its garden, field, and forest produce, with specimens of the insects injurious to agri-horticulture, all of them accurately labelled, and with books to refer to. The agriculturists need not wait on Government for this. Whether colleges be opened or no, every county should have its own museum, to admit of ready references. I think that I may speak on this point with some confidence. I founded the Government Central Museum at Madras, and the Mysore Museum at Bangalore, and my experience enables me to say that, if they will aid each other by interchanges, most of the county towns of this country might have their own useful agricultural and forest museums within a year.

2, Oxford Street, Hyde Park, EDWARD BALFOUR.
20th August, 1885.

MANUFACTURE OF CUTCH IN BURMA.

In the hope that some readers of the "Indian Forester" will come forward and help us to solve at least one of the problems that are now puzzling us, I send you the few following rough and incomplete notes on cutch and its manufacture in Burma.

Cutch boilers here recognise four varieties of the cutch tree (*Acacia Catechu*), distinguished by their bark and the colour of the heartwood, *viz.*—

i. Sha-ni, or Red Cutch.
ii. Sha-wa, or Yellow Cutch.
iii. Sha-net, or Black „
iv. Sha-bya-kyaung-mwè, or Blue Cutch.

The first two have a bark like the tamarind tree, the other two have a bark like the htauk-kyan (*Terminalia alata*, Kurz). Of these four varieties the Red Cutch is considered the best; the cutch manufactured from the Blue Cutch will never "set" by itself, so it is always mixed with the cutch from one of the other varieties.

The great difficulty that cutch boilers have to contend against is that the cutch will not set (or "sleep" as they call it), and to get over this many expedients have been resorted to, but as yet without any great success.

According to its hardness merchants separate manufactured cutch into—

(i). Sha-ma, or hard cutch, which can be chipped or broken. At present it is worth about Rs. 40 per 100 viss.

(ii). Let-lun-ya, or plastic cutch, which can be rolled into a ball with the hands without sticking to them. Present value Rs. 30 per 100 viss.

(iii). Pet-tok, or viscous cutch. This is usually rolled up in large leaves ("pet") as soon as it is made, and sold in this condition. Hence the name. Present value Rs. 26 per 100 viss.

(iv). Kyin-hlaung-hmo-kat, or hmo-kat. This is much more liquid than the former, and is poured into bamboo baskets lined with leaves as soon as made. Present value Rs. 20 per 100 viss.

From November to February in each season sha-ma is almost the only cutch turned out, and, except in the districts where the Blue Cutch tree is very plentiful, hmo-kat is the exception. As the season advances less and less sha-ma is turned out, and unless great care is taken in the cooking and in the selection of suitable trees, one of the inferior kinds will be produced. From April to October sha-ma cannot be produced except with the greatest trouble and where certain trees are plentiful.

One of the principal elements of success in cutch boiling is the presence of what the Burmans call "ugyi." These are small white specks of lime (presumably) deposited in the fibre of the wood. From trees rich in ugyi sha-ma may be obtained all the year round, hence a cutch boiler is always on the look out for them. He professes to be able to discover them at a distance, as he says that they have a rugged, light grey bark like the tamarind, and are usually found on high ground. Having discovered a tree which he supposes to contain ugyi

he blazes it to the heartwood on two sides; at first the ugyi are not discernible, but after 7 or 8 hours they begin to appear, and when the cutch boiler re-visits his blazes the following morning they are quite apparent. If a dead tree be blazed in a similar manner the ugyi, if present, are apparent at once.

According to the position of the ugyi in the section of the tree the woods are classed by cutch boilers as follows:—

i. Tè-lon-bya, *i.e.*, all over the section. 

ii. Pat-yan, *i.e.*, in a circle. 

iii. Swè-bauk, *i.e.*, on one side only. 

Ugyi are mostly found in sha-ni, seldom in sha-wa and never in sha-net or sha-bya; always in the heartwood and never in the sapwood.

Noticing the effect of these ugyi on the cutch and believing that the addition of a few handfuls of lime would serve the purpose equally well, the cutch brokers some years ago ordered their agents to try the experiment. The soft cutch certainly turned out hard, but the lime was immediately detected by the merchants, and the cutch could not be disposed of at any price. This seems rather absurd, as it is generally supposed here that the English market cannot tell good cutch from bad, but the fact remains the same, and no cutch boiler will now add lime under any circumstances. I may relate, *en passant*, that for the last three years a gentleman has been buying pure cutch in the district, and boiling it up again with 25 per cent. of godown sweepings. This he sells in the English market, and I am informed by the agent of a rival firm that this adulterated stuff fetches as high rates in the home market as the best cutch that can be shipped from Burma.

I had received information that in Upper Burma it was customary to mix the ordinary cutch with certain proportions of cutch made from trees other than the acacia, both for improving the colour of, and giving hardness to, the cutch; the two principal trees being the than-bin (*Bignonia ?*) and htauk-kyan-bin (*Terminalia alata*, Kurz). I obtained the services of an old cutch boiler from Upper Burma, and sent Ranger Moung Pè, who has been trained at Dehra Dún, out with him to carry on some experiments. The than-sha (*i.e.*, the cutch made from the than-bin) had been described to me as being of a beautiful golden yellow and always hard, but the than-sha that was obtained in these experiments was of a deep claret colour,

and intermediary between pet-tok and let-lun-ya as regards its consistency; this than-sha was made in the usual way, except that the bark of the tree was used instead of the heartwood. For the same quantity of material one-third more cutch was obtained than from the ordinary cutch wood. Great trouble was experienced in the boiling to prevent the liquid boiling over; moreover, it gave off a vapour which had a most intoxicating effect on the cutch boilers, and occasioned loss of appetite and general debility for a time. The cutch that was obtained was afterwards boiled with the ordinary "hmo-kat" in the proportions of ¼ than-sha to ¾ hmo-kat, and the result was a good coloured pet-tok cutch, worth about Rs. 25 per 100 viss; equal proportions of than-sha and hmo-kat gave almost the same result. They say that when adding the Than in Upper Burma in order to obtain a good colour a large handful of the Than bark is placed at the bottom of each chatty, which is then filled up with chips of acacia in the usual manner.

But a very small quantity of pure than-sha finds its way into the market; it is sold at the same rate as the ordinary pet-tok.

Another set of experiments were carried out with the htauk-kyan-bin (*Terminalia alata*), but with no greater success. I had been informed that the heartwood of this tree was used to make the cutch, but the Upper Burman declared that this was an error, and that the powdered bark only was used. Some of this bark is extremely rich in ugyi. Moung Pè first tried to obtain a cutch by boiling the bark as in the case of the than-bin, but he could only get a thickish red liquid, which, when boiled up with hmo-kat, made no difference to the hardness of the product. Some of the bark was then powdered and boiled up with hmo-kat, which had the effect of hardening the cutch up to pet-tok, but owing to its having lost its transparency its market value was not increased. I intend to try and obtain cutch from the heartwood of the htauk-kyan on a future occasion.

These few experiments, incomplete as they are, would lead us to suppose that both the than-bin and the htauk-kyan-bin are richer in some salt than the sha-bin (cutch tree), and that this salt has a marked effect on the hardness of the cutch produced. Personally I felt convinced that a series of chemical analyses carefully carried out and extended over all seasons of the year would show us that soft cutch can be hardened by the addition of one or more simple salts, and Mr. Popert has promised to try and arrange with Dr. Romanis, the Government Analyst in Rangoon, to have such a series of analyses carried out. In the mean time if any one would kindly suggest any experiments likely to lead to the solving of this problem I shall only be too glad to try them. I have specimens of all the materials used in the above experiments, as well as specimens of the results obtained, and if any of your readers would care to have samples I will willingly forward them.

Perhaps some Forest officer in India will kindly inform us, through your columns, whether they experience the same difficulty in getting the cutch to set, and if they know of any way of getting over the difficulty.

H. SLADE.

SAL TIMBER IN THE GARO HILLS.

WE have received the following statement of the dimensions of sál trees in the Dambu forest in the Garo hills and of their yield in metre gauge sleepers. It is probable that except in the Central Provinces and a few remote forests in Kumaon and Nepal, that sál trees of the above dimensions are no longer to be found in India :—

Trees.		Girths 4′ from base.	
345	between	6′ and 7′	Very few hollow trees, not more than six or seven altogether.
279	„	7′ „ 8′	
141	„	8′ „ 9′	
85	„	9′ „ 10′	
35	„	10′ „ 11′	
8	„	11′ „ 12′	
6	„	12′ „ 13′	
1	„	14′ „ 15′	
Total, 900			

Average number of $6\frac{1}{4}$ feet logs to each tree (10).

Produce of metre gauge ($6\frac{1}{2}' \times 8'' \times 4\frac{1}{2}''$) sleepers from 10 trees

Tree.	Girth.	Good sleepers.	Rejected.	
1	11′ 3″	131	11	
1	8′ 5″	106	5	
1	8′ 2″	47	7	Bent tree and bad wood.
1	7′ 7″	88	1	
1	10′ 0″	94	4	
1	9′ 0″	57	...	
1	8′ 0″	94	...	
1	6′ 2″	33	...	
1	6′ 5″	36	2	
1	10′ 0″	62	4	
	Total,	748	34	

Average 74·8 sleepers per tree. Of course these are large girths.

The Dambu forest, which was discovered by the Editor in 1880, and described in the "Indian Forester," has lately been worked by a firm who agreed to pay the Assam Government Rs. 20 per tree, but owing to the difficulties of export and labor, the work has proved very unprofitable, in spite of the magnificent dimensions of the sál trees, and the splendid quality of the timber.

TABLE SHOWING PERIODS OF RIPENING SEEDS OF CONIFERS IN THE HIMALAYAS.

Species.	First appearance of male flower.	First appearance of cone.	Pollen shower.	Cone scales closing.	Ripening of seed.	Time between first appearance of cone and falling of seed.	Remarks.
Cedrus Deodara, Deodar.	26th June	16th August	1st October	24th October	1st October	14 months	Male flower and young cone never found on the same tree. Cones erect. Empty cones non-persistent. Scales fall off separately when seed is ripe.
Abies Smithiana, Tos, Rai, (Spruce).	15th April	20th April	4th May	14th May	November	7 months	Empty cones persistent. Cone pendulous and falls complete, scales not detached.
Abies Webbiana, Rai, Morinda (Silver Fir).	15th April	20th April	4th May	14th May	November	7 months	Cones erect and break to pieces when seed is ripe.
Pinus excelsa, Kail, (Blue Pine).	16th April	26th April	3rd May	5th June	November	19 months	The same tree may have (1) male flower, (2) young cone, (3) ripening cone, (4) empty cones persistent. Cone erect when young, pendulous when mature, and falls complete, scales not detached.
Pinus longifolia, Chil, (Chir).	15th Feby.	25th Feby.	1st March	15th March	1st July	29 months	Young cones not only found on same tree as male flower but even on same leaf-bud or stem. One tree may have 4 years' cones on it at one and the same time and also the male flower. Cones pendulous. Empty cones long persistent. Scales not detached when falling. The dates vary with elevation. The above are for the higher elevations.

6th May, 1886.

J. C. McD.

THE RE-AFFORESTING OF WASTE LANDS IN IRELAND, AND THE APPLICATION OF FORESTRY TO THE REMEDY OF THE DESTRUCTIVE TORRENTS AND FLOODS OF THE CATCHMENT BASINS OF THE CHIEF RIVERS OF IRELAND.

By D. HOWITZ, *Forest Conservator, Copenhagen.**

THE reclamation of the waste lands in Ireland has recently occupied the attention of Parliament and Dr. R. S. D. Lyons, Member for Dublin, has specially taken up the matter. At his request Mr. D. Howitz, an officer of the Danish Forest Department, visited Ireland, and examined the most denuded portions of the country where reboisement operations are most urgently needed, and especially the Lough Neagh catchment basin, where the Government have already undertaken a series of engineering works to stop the periodical inundations, to which the country below is subject. Some plan for re-wooding the surrounding highlands and slopes is required, by which the present annual recurrence of sudden and disastrous floods may be checked, a perennial supply of water secured for the streams so as to render them navigable throughout the year, and the formation of malarious swamps prevented, objects which, in the opinion of Mr. Howitz, no amount of the most skilled engineering will be able to accomplish. If the re-afforestation of a comparatively small area is successfully carried out, the great benefits derived therefrom will be practically demonstrated to the country, and the work will, we may hope, be at once taken up with enthusiasm in every other locality which now suffers from the absence of forest.

Mr. Howitz begins by referring to France, Switzerland, Spain, Sicily and other countries in which the work of re-wooding denuded hill-sides and planting up bare swampy tracts has been pursued with more or less vigour and the beneficial results derived from the operation thoroughly recognised. To France is due the glory of having taken the lead and set the example to the rest of the world. The forest rules framed by the French Government for the reboisement of the Alps and those drawn up, on the model of the French rules, by the Swiss are recommended to the consideration of Parliament.

In Ireland the hills have once been clothed with forest of valuable timber trees, remains of which are to be found everywhere in the bogs, whereas in the Alps, the Pyrenees and the

* After the very remarkable paper on the same subject by Dr. Schlich and printed in a former issue, a short notice of this able report, which was presented before the House of Commons, and is also referred to by Dr. Schlich, will not be uninteresting.

Ardennes and in Auvergne only the less valuable and hardy trees can be grown. Then again the shorter carriage to the sea and the proximity of England, the largest importer of wood in the world, gives to the proposed works in Ireland a vastly more favourable financial aspect. During the period of seven years closing with 1878, the average annual importation of wood into England was 290,000,000 cubic feet, and exceeded the collective importation of France, Germany, the United States of America, Holland, Belgium, Denmark and Spain by 91,000,000 cubic feet. Of the wood taken by England from foreign countries 36 per cent. consists of building timber of large dimensions, 55 per cent. of boards and scantlings, and 5 per cent. of coopers' wood.

The Norwegian forests have ceased to export, and the quality of Swedish timber is deteriorating every year, as the necessity for meeting the demand by cutting young, immature and inferior forest is increasing. Germany can scarcely supply its own markets, and the exportation of timber from the Baltic will soon cease altogether. The capabilities of the "virgin forests" of Russia have been much exaggerated. Thus the timber supply of England is already an urgent question, and the Irish producer of the ordinary market-classes of timber, with the great facilities of transport he will command, will be able to demand his own price and consult his sole convenience in felling and putting his wood into the market.

The greatly increased demand for telegraph poles, sleepers, pit-props, &c., &c., for which pine wood is chiefly used, indicates at once the species of trees to employ in the afforestation of the waste lands. The pines and other conifers are very rapid growers, and the climate and soil of Ireland are eminently suited for their production.

Of the 20 million acres which constitute the area of Ireland, about one-quarter is well suited for forest, and this proportion of forest to other land is not at all too high for that country. All the ranges and bogs, all the barren and desolate coast lands, and a great many of the very poor grass lands, are natural forest land, and should be maintained and treated as such. Many hundreds of thousands of acres do not yield 6*d.* per acre per annum, and actually the greater portion of the 5 million acres do not pay even 1*d.* There are large areas of grass land and many fenced paddocks on the ranges, where the heather and the bracken are so abundant, and rocks and stones cover the ground to such an extent, that the rent per acre is not more than from 1*s.* to 2*s.*

Mr. Howitz shows how under forest the net income would be at least £1 per acre per annum. He puts down the first cost of establishing a pine plantation over 100,000 acres at £4 per acre, or £400,000 in all. This sum at 4 per cent. compound interest, together with cost of superintendence, roads, maintenance, &c., comes up to roughly £2,000,000 at the end of 30

years, when the plantation would be worth all round at least £50 per acre, exclusive of the thinnings and other small produce that may be obtained during this interval of 30 years. Thus the net return would be at least £1 per acre per annum. Mr. Howitz considers that the actual cost would prove to be 25 per cent. less than his estimate, and that the returns would, therefore, be probably nearer £2 per acre per annum.

Mr. Howitz anticipates no great difficulties in raising new forests anywhere in Ireland. Even the outer storm-beaten belts must ultimately become thoroughly established. In less than half a century the now bare hills would be covered with valuable forest, and through the protecting influence of this forest growth, the present meagre pastures and barren fields would become fertile meadows and smiling expanses of rich cultivation.

The effect would be a prosperous, contented population. No amount of mere legislation without the reclamation of the waste lands by means of forest planting will ever pacify that unhappy country. The question of re-afforesting these bare wastes is thus a question of life or death to the Irish. Every year of delay in undertaking it will make the task more difficult with the rapidly increasing deterioration of the soil both of the waste areas and of the adjoining fields, which are immediately dependent on them for their fertility.

The question now is how to commence and carry out a scheme of re-afforestation which will succeed and be taken up without clashing against vested interests and raising a storm of opposition. Mr. Howitz estimates that the total area in which a beginning must at once be made amounts to about 4,000,000 acres, comprising the basins of the Shannon, Lough Neagh, Blackwater and Barrow, a few smaller basins and a long tract in the shape of a horseshoe stretching from the north through the western districts to the south-west.

As the treatment of these various areas must be very similar, Mr. Howitz, as said before, devoted his attention specially to the Lough Neagh basin, the second both in size and importance. The area of that basin is just over 2,200 square miles, of which about 18 per cent., or 400 square miles (256,000 acres) are fit for forest culture, although only about 100,000 acres are at present available. The fall of the ground is only 9 inches in the mile, which is not sufficient to carry off heavy rain. The average annual rainfall is 36 inches, of which as many as 21 inches may come down within 4 months, and often as much as 1 inch in 24 hours. The skilful engineering works already executed in this basin will, Mr. Howitz is convinced, never be able to prevent ultimate disaster or fully dispose of the flood-waters. Indeed, no amount of engineering, he adds, will ever be able to do it.

The real obstacle, the denudation of the slopes and ridges of the whole catchment area of the basin, must be removed before any real and lasting good can be done, as has been amply demon-

strated by experience in the valley of the Rhone and other rivers, where gigantic and expensive engineering works have utterly failed to stem the mountain torrents or prevent them from carrying devastation into the valleys and plains below. There the re-wooding of the great mountain slopes in the catchment area is being prosecuted with all the skill of science, the energy of devotion and the liberality of far-seeing statesmanship, under the most difficult and discouraging circumstances—extremes of temperature, sudden and heavy rains, long and severe droughts, and almost total absence of soil. The slopes have been so long denuded of trees and shrubs that the rain and snow have washed and carried away every vestige of fertile earth, leaving only a small quantity of it in crevices and on narrow ledges. Such a catastrophe should be conjured away in time in Ireland, but it must surely occur, if the work of re-afforestation is not taken in hand before long.

The difficulties in those countries, both physical and climatic, are so enormous in comparison with those to be encountered in Ireland, with its island climate, the proximity of great ocean currents, including the gulf stream, the abundance of vegetable mould to plant in, and the favourable geological structure, that it would be extremely unwise to delay the work until some of these natural advantages had disappeared.

Mr. Howitz then goes on to formulate his suggestions for work. He advises (1), that the re-afforestation of the 100,000 acres available in the Lough Neagh basin should be at once taken in hand, and carried out independently of work in any other area; (2), that plans for the treatment of the Shannon and other basins should be prepared ; and (3), that experimental plantations should be started in the more difficult highlands and coast areas of Donegal, Leitrim, Sligo, Mayo, Galway, Clare and Kerry, temporary nurseries being used, and the time for planting, owing to the sudden changes of the Irish weather, being left to the discretion of the local agents. In making the above proposals, he discusses in a pretty full manner the general rules to be observed in sowing and planting and in the establishment of nurseries. He considers that 100,000 acres may be completely re-afforested every year, requiring from three to four hundred million plants. To State initiative he would add private enterprise by encouraging private planting by means of loans of money.

As regards the agency by which the work should be carried out and controlled, he suggests the appointment of a standing Forestry Committee, with a qualified Forest officer as Secretary and head quarters at Dublin.

Should the measures sketched out by Mr. Howitz be carried out, whether the Home Rule and Land Purchase bills be passed or not, Ireland will soon once more become the Emerald

Isle with a contented and prosperous peasantry as fine as any in the world.

TIMBER IN NEW ZEALAND.*

It is satisfactory to note that the Government of New Zealand is taking steps for the preservation of the pine forests of that country from the hands of lumberers and sawyers. Few countries have forests of such rich variety or so easily accessible, and the injury caused by indiscriminate cutting has not yet attained any extensive proportions. There is, therefore, a wide field for scientific forestry in New Zealand, a fact of which the colonists themselves seem to be aware. Timber is largely consumed locally for building and railway purposes. There is growing up also an export trade to Australia, where timber is in strong demand, which only requires the opening up of harbours on the west coast of New Zealand to grow to very large proportions.

The South Island forests are more extensive and important than those of the North Island, and generally produce better timber. It is proposed in this paper to give a brief account of the forests of the colony, taking them by Provinces and beginning from the south.

Southland, the position of which is sufficiently described by its name, produces the red pine, black pine, white pine, silver beech and a few other varieties. The red pine, which is said to be of unusually fine quality, straight-grained, close and silky, is the tree most largely converted into timber. Trees 3 feet and 4 feet in diameter are often found, but the average diameter is from 1½ feet to 2½ feet, and trees of this size produce timber 30 feet to 40 feet in length. The white pine is also worked wherever found, and the silver beech is used largely in the Longwood Range. Ironwood is found in some abundance, but on account of its great weight is little used. Nearly all the timber cutting is done in saw-mills erected in the forests, with tramways laid down on which to bring the logs to the mill. The output of the Southland mills is estimated at 25,000,000 superficial feet of inch thickness per annum, most of which is carried to the market over the Southland Railways. A royalty of 3*d.* per 100 superficial feet is the sum demanded by Government on leases to saw millers; but the system of checking the outturn is defective, and it is believed that large frauds have taken place. The saw mills are mostly worked by steam, and are fitted up with all the newest machinery. Timber can be delivered on the railway for about 4*s.* per 100 superficial feet. In Southland out of a total forest area of some 350,000 acres, not more than

* Most of the information contained in this article is derived from a Report of Prof. Kirk, F.L.S., to the Government of New Zealand, 1885.

35,000 acres have been attached by the saw mills, and there still remain some 200,000 acres of accessible virgin forest, the remainder of the forest area being either mountainous or too poor to be worked with profit.

North and east of Southland lies the province of Otago, with a coast line on the east of the island some 400 miles in length. The forest area is estimated at about 3,000,000 acres, of which at least 1,000,000 acres are of really good quality and easily accessible. The Dunton forest is a magnificent tract of 200,000 acres covered with the mountain beech (*Fagus Cliffortoides*) and tooth-leaved beech (*Fagus fusca*). From the latter splendid timber is obtained, the trunks often exceeding 60 feet in length and squaring 26″ × 26″. Trunks 62 feet in length have been split into posts and rails without a single foot of waste ; and the timber is exceedingly hard and durable. In the Dunton forest there are blocks 6 or 8 miles square, of which three-fourths are covered by fine trees of these dimensions. The Dean forest is of larger extent, and produces silver beech (*Fagus Menziesii*) and all the various pines. Black pines squaring 30″ × 30″ are not uncommon, and many have a curiously fluted grain which makes them very valuable for cabinet work. Another enormous area is covered by the Catlin River forest, which lies on the south-east corner of the island, and abounds in pines of all kinds and many fine blocks of ironwood. Indiscriminate licenses caused much damage to this forest in the early days of the colony, but the loss is now being repaired. It was then the custom to give for £5 a year a license empowering the holder to cut wherever he pleased and in whatever quantities, a system well calculated to ruin the forest completely. But fortunately the timber trade in this part has for some years been slack on account of the absence of the railways which have largely stimulated trade elsewhere ; and natural reproduction has gone far towards filling up the gaps caused by reckless cutting down. The beautiful lakes of Wakatipu and Wanaka have suffered in a similar manner. Formerly their banks were covered with myrtle, olearia, veronica and palm-lilies, and the scenery was of exquisite loveliness. Now in many parts the hill-sides are charred and bare ; firewood cutters make havoc wherever they choose to go, and the grace and beauty of nature are replaced by stumps and ashes left by English squatters.

Westland, which lies on the maritime slopes of the Southern Alps, contains some 2,000,000 acres of first class forest, and 600,000 acres of scrub and jungle. The Westland forests contain finer pines than are found anywhere else in New Zealand. The red and yellow silver pines (*Dacrydium Westlandicum* and *D. intermedium*) flourish in large numbers, and produce timber of great size and durability. These forests are also remarkable for their mountainous and picturesque beauty. The belts of pine and totara are succeeded by ironwood (*Metrosideros lucida*) and

cedar (*Libocedrus Bidwillii*), varied by the native lilac (*Quinbinia serrata*) and the tea tree (*Leptospermum ericoides*) and many ornamental shrubs. The Westland timber trade employs numerous well fitted saw-mills where timber of the finest quality is produced. But the trade has for some time declined owing to the absence of railways, and the corresponding rise in the Southland timber industry. It is hoped that when the West Coast Railway is constructed the Westland timber trade will again flourish, to be further stimulated by export of timber from the western harbours to Australia.

The Provincial district of Canterbury has a comparatively small area of available timber forests, and much has been cut away by the ubiquitous saw-millers. In the Makarora valley is a large area of silver beech of excellent quality, the wood being capable of being split into shingles with the greatest ease; and practically it is the only timber used locally, although on the higher slopes cedar and ironwood abound. Another forest, on Oxford hill, consists almost wholly of the entire-leaved beech (*Fagus solandri*) with trunks 30 feet to 70 feet in length, and squaring from 18″ × 18″ to 36″ × 36″. This timber when mature is very durable, making sleepers and fencing of good quality. In Canterbury Government land is sold at £2 an acre including timber, and licenses for timber cutting are not given. It is difficult to see why such a one-sided arrangement has been adopted by the Government, seeing that the available timber area in this province is of limited extent, and the timber by itself is often worth as much as £15 an acre.

In the districts of Nelson and Marlborough there are many fine forests similar to those already described. Much damage has been done by indiscriminate cutting, the direct result of the extraordinary licensing system which prevails. It is the custom to allow mills to be worked on payment of a royalty to Government of 6*d*. per 100 superficial feet. But the measurement is left entirely to the contractor, who sends in his returns only once in six months, and is subject to no sort of supervision. It is the common custom to measure logs at the small end only, a fact of which every one concerned is aware; and yet the Government takes no steps towards protecting its own interests. The annual amount actually received by the Crown as royalty in the district of Marlborough does not exceed £390; and yet the outturn of timber is estimated at some 8,500,000 superficial feet, a quantity which with proper supervision should bring in a return to Government of at least £2,000 a year.

The forests of the North Island, though not so extensive as those of the South Island, are still numerous and very valuable. All the pines and beeches abound, and the North Island Central Railway runs through some of the best tracts of timber-producing country. In Auckland very fine forests of kauri exist, the

trees being of magnificent size and proportions. Clear straight trunks 50 feet to 60 feet high at the first branch, and from 4 feet to 8 feet in diameter may be seen growing together rank after rank. The timber of the kauri is of the finest quality, combining great strength and durability with a compact and silky grain. The best kauri forests are situated on broken ground where the forest tramways so commonly used in the level country of the South Island cannot be constructed. Logs are therefore generally floated to the saw-mills on the numerous creeks and rivers. For the conveyance of timber cut at a distance from the water, "rolling roads" or broad inclined tracks 30 feet or 40 feet wide are made. Every advantage is taken of the natural slope of the ground, stumps are cleared out and hollows filled up. The logs, cross-cut into suitable lengths, are forced along by means of "timber jacks," which the bushmen use with great dexterity, moving the largest logs with great accuracy and speed. Where the logs are large and the stream small, it is often necessary to build dams at considerable expense, in order to obtain a proper depth of water. Boards are turned out at the saw-mills at a price of about 10*s.* per 100 superficial feet. Doors and window sashes are largely manufactured in the district of Auckland, kauri being the timber chiefly used. The Auckland saw-mills are said to be among the best in the world. All the best machinery is adopted, and the newest improvements are made use of. But the kauri forests cannot long stand the present incessant felling, which, it is calculated, will work them out entirely in the course of 15 or 20 years. No system of conservation has yet been introduced, but of its need there can be no doubt. The Government of New Zealand will be acting wisely if it introduces at an early date some scientific and effectual means of preserving and maintaining the exceedingly valuable forests which it possesses. The question is complicated by no pressure of population or demand for grazing as in India, and as far as can be judged requires very simple legislative action. It would seem that there is a good opening in New Zealand for Forest officers of training and experience. Any one going there from India would find a climate of ideal excellence, exquisite scenery, and a society above the average, but no shooting or shikar, there being few birds and no wild animals but pigs and rats.

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FOREST ORGANIZATION FOR BEGINNERS.

(*Continued from page 244*).

CHAPTER V.

COLLECTING FURTHER STATISTICS: FORMULATING RESULTS.

While the forest is being explored in the manner described in the last Chapter, notes should be made regarding the future treatment of each group or compartment. Not that it is necessary to carry out the views expressed in the notes as to the future management of any particular group, as modifications may have to be made when the group comes to be treated as part of a series,* but in order to get a basis on which to form a *general plan of operations. Particulars to notice are, for instance*, the advisability of a change of species, owing to bad growth of the standing stock, or to other reasons: the best mode of regenerating groups or re-stocking blanks and wastes: improvements which appear necessary in regard to roads, rides, young growth (stopping, thinning, &c.), drainage, and so forth.

Statistics of prices of all descriptions of principal and minor produce should also be collected, and inquiry made into the requirements of the population in the vicinity of the forest and its rights, or privileges, to take produce free, or on payment of royalties, together with a brief history of the forest, including a statement of the tenure of the owner, of the rights of others, and of its past treatment. A note should also be made of any lands of others, either inside, or outside, the forest, which it would be desirable to acquire for forest purposes by exchange or purchase.

In a forest which is being organized for the first time, it will not often be possible to give returns of the past yields of groups separately, but records of the yield of the whole forest in timber,

* When a number of groups are worked in connection with each other, so as to make up the annual yield during the whole revolution, they are said to constitute a series.

firewood, (thinnings separately,) and minor produce for several years back will often be available, together with the receipts and expenditure. It will then be possible to fix with more or less certainty the average gross and nett value of the standard unit of measure for each species and for each description of produce: the most useful kinds to grow: the best revolution to adopt: and the quantity of material which can be disposed of yearly.

Other points to observe are:—The principal markets, roads, or other means of transport (railways, rivers). Large industrial undertakings demanding a constant supply of produce, such as paper and sawmills, mining and smelting-works; price of labour, and whether it is abundant or difficult to procure when required; nature, frequency or comparative absence, of forest crime; the temporary and permanent staff required to guard the forest and to carry out forest operations. Any other useful information likely to affect the working of the forest should be noted, and in any case in which improvements seem possible suggestions should be made accordingly.

The more important data should be scheduled in the following statements:—

1. Statement of Area.
2. Statement of Groups.
3. Statement of Age-Classes.
4. Statement of Boundary-Marks.

1.—Statement of Area.

This may be drawn up in the following form:—

Detailed Statement of Area of Kodali Range, consisting of 12003·05 *acres, of which* 11200·55 *are forest-land, and* 802·5 *roads, rides, ponds, or unculturable waste*: 1886.

Locality.	Compartments and sub-compartments.	Culturable forest-land. Acres.	Unculturable land.	Total.	Remarks.
Belmal, ...	1*a*	10·05	...	...	
	b	21·30	...	...	
	c	17·02	...	...	
	d	31·57	...	...	
	e	...	1·02	79·96	Pond.
	2*a*	15·12	...	...	
	b	28·91	...	...	
	c	45·30	...	89·33	
	3*a*	49·32	...	...	
		&c.		&c.	

Particulars of groups in the first series of the Nandi beat of the Kodali Range, Pundra Division, in 1886.

COMPARTMENT No. 1.

Locality.	Sub-compartment.	Area, acres.	Species.	*Age.* Years.	*Age.* Class.	*Quality.* tation.	*Quality.* Group.	Leaf cover.	Density.	Description of Station.	*Cubic contents, feet.* Per acre fully stocked.	*Cubic contents, feet.* Per sub-compartment.	*Increment, cubic feet.* Per acre.	*Increment, cubic feet.* Whole area.	Remarks and suggestions for future management.
Belmal, ..	*a*,	5·51	·6 Tk., ·4 Ter.,	45–55	III.	·2	III. Tk., I. Ter.	·6	·6	Formation gneiss, soil shallow, very light loam, with slight layer of humus under Xylia; other parts covered with a growth of short grass: gentle slope inclining to the N. E.	..	10,414			*Abbreviations.—Tk.*, teak: *Ter.*, *Terminalia tomentosa* : *Xy.*, *Xylia dolabriformis*. (*a*). Naturally-grown group, situation unsuited to teak, getting very open, broadcast sowing of bamboo for ground-cover desirable.
	b,	20·11	Xylia, ..	50	III.	·8	IV.	·9	·9		4,050	73,301			(*b*). Good, vigorous growth, humus-covering to soil: requires thinning lightly in parts.
	c,	10·57	Waste, ..	..	..	·8	..	..	..		..	..			
	d,	5·50	·5 Tk., ·5 Xy.,	90-100	V.	·6	I. Tk., III. Xy.	·4	·4		2,420	5,324			(*c*). Abandoned field, 10 years fallow: plant up, in combination with a crop of grain, with bamboo, and Xylia with ·5 of teak. Water close to in nullah. Rank growth of grass.
	e,	7·57	·5 Tk., ·5 Ter.,	15	I.	·8	IV. Tk., III. Ter.	1·0	1·0		..	..			(*d*). Growth very bad, should be cut away, and planted up in the same manner as (*c*), water close to in nullah. Long grass. (*e*). Alternate rows of teak and Terminalia planted at 5 feet distances. Growth good.
Total, ..	..	44·26													

2.—Statement of Groups.

The preceding form, (p. 289,) which is similar to that given at page 2,* may be used in this case for series subject to the method of regular cuttings (*see* p. 3*), at least one page being given to each compartment. The unstocked area (taken up by rides, &c.) may be stated at the beginning or end. It will seldom be necessary to give the contents of young groups, or those which are not likely to be exploited during the first period or two. This matter will depend in a great measure on the system of management adopted, as we shall see further on when examining the methods for determining the annual yield.

This form naturally requires modification in the case of forest treated by the primitive method, or the overwood of stored coppice. In the former case, the columns for the quality-classes and age-classes of groups will disappear, and, instead of the cubic contents of the whole group, those of superior diameter-classes will generally have to suffice. The increment-column should show the increment per cent. for each superior diameter-class, and a column may be added showing the estimated number of stems in each such class. Similar alterations are evidently advisable in the case of overwood in stored coppice.

3.—Statement of Age-Classes.

The object of this statement is to show at a glance the area occupied by each age-class of mixed and unmixed groups. There should be a separate statement for each series of a range. The quality-classes of groups should also be stated.

The following form is suitable for series subject to the method of regular cuttings; for other systems, diameter-classes may have to be substituted for age-classes, and the number of trees, or cubic feet, for the acreage.

Statement showing the Age-Classes of the First Series of Kodali Range in 1886.

Sub-compartment.	Quality-class of the group.	Class I. 1—20 years. Acres.	Class II. 21—40 years. Acres.	Class III. 41—60 years. Acres.	Class IV. 61—80 years. Acres.	Class V. 81—100 years. Acres.	Class VI. 101—120 years. Acres.	Class VII. 121—140 years. Acres.	Blanks.	Wastes.
1 *a*	IV.	...	...	...	...	...	5·75			
b	IV.	...	...	...	10·41					
c	III.	...	...	...	...	25·10				
d	IV.	...	...	...	15·73					
7 *c*	I.	10·45	...							
d	I.	5·13	...							
13 *a*	III.	...	13·5							
Total, ..		15·58	13·5	...	26·14	25·10	5·75			

* January No. of "Forester," 1886.

4.—Statement of Boundary-Marks.

Besides being shown on the map, it is well to have a register of boundary-marks, so that, in the event of any disappearing, the exact position in which they should be may be easily found. The following form includes all the data which it is desirable to have recorded, but, of course, it will often be impossible to keep so complete a statement.

Statement of Boundary-Marks in Kodali Range in 1886.

Adjacent compartment.	Number of mark.	Description of mark.	Distance to boundary mark on the right, facing inwards. Yards.	Angle included by lines joining centre station with boundary marks on right and left facing inwards.	Remarks.
1	1	Stone	150·45	75° 31′	Meets the stream.
1	2	do.	200·30	105° 10′	On edge of meadow.
			&c.		

It will often be possible to schedule other important matters, such as the past annual yields and average prices of different kinds of produce, which are more easily examined in a concise form.

SECTION IV.—DETERMINATION OF YIELD.

Chapter VI.—Determination of the yield of forests regenerated by the method of regular cuttings.*

In large forests, the *ultimate* object to be attained is the annual cutting of a tolerably uniform quantity of material of the most useful descriptions, combined with a good sequence of cuttings in each *block*, a term which is used to denote the parts of a forest lying between any two main-rides, or their substitutes. A good sequence of cuttings is that in which the age-classes in a block follow each other in order of age, the youngest groups being, at the beginning of the revolution, at the end from which storms are mostly to be feared, and the oldest at the opposite

* The term *regular cutting* is here used in the sense in which it is defined at page 8 (January No.). It is essential to note this.

end. By this arrangement, when the oldest groups, or portions of them, are cut away, the trees left standing—which, if they have grown up in thickish cover, are sure to be weakly-rooted—are not suddenly exposed to the full force of the most dangerous winds; they are protected by the groups in the block lying in front of them. The young growth and the isolated mother-trees in groups naturally regenerated are also sheltered for some time by the forest in front of them. *In very irregular forests, a good* sequence of age-classes cannot always be attained in one revolution, nor the cutting of an even tolerably-uniform quantity of material, but it is generally possible at least to prepare the way, without much loss, for the gradual attainment of these ends.

The principal methods of determining the annual yield are:—

1. The method of equal annual areas.
2. The method of periodic areas.
3. Hartig's method.
4. The combined method.

1. Method of equal annual areas.

This affords the simplest means of fixing the annual coupe, the area of which is found by dividing the area of the series by the number of years in the revolution. If the area of a series is 1,000 acres and the revolution 50 years, the area of the yearly coupe would be $1000 \div 50 = 20$ acres, and if each coupe be re-stocked immediately after a cutting, there will evidently be a sustained yield after the first revolution, provided that the *station is of uniform quality and that nothing arises to* disturb the regular sequence of coupes.

If, however, the station is not of uniform quality, the yield may vary considerably, especially in forests subject to long revolutions, and for this reason the method of proportional coupes is sometimes adopted: that is, the area of the coupe is made inversely proportional to its relative yield.

Supposing, for example, that we have a series stocked with coppice, and consisting of the following compartments, and that the revolution is 30 years.

Compartment 1, of 50 acres, capable, it is estimated, of yielding in the 30th year 2,550 cubic feet per acre.

Compartment 2, of 65 acres, capable of yielding 2,040 cubic feet in the 30th year.

Compartment 3, of 45 acres, capable of yielding 1,730 cubic feet in the 30th year.

We would then have a total production during a revolution of

From No. 1, ...	$50 \times 2{,}550 =$	127,500 feet.
From No. 2, ...	$65 \times 2{,}040 =$	132,600 ,,
From No. 3, ...	$45 \times 1{,}730 =$	77,850 ,,
	Total, ...	337,950 ,,

The mean yearly production *would, therefore, be for a complete series*

$$\frac{337950}{30} = 11{,}265 \text{ cubic feet,}$$

and the size of a coupe would be in

Compartment 1, ... $\frac{11265}{2550} = 4{\cdot}41$ acres.

" 2, ... $\frac{11265}{2040} = 5{\cdot}52$ "

" 3, ... $\frac{11265}{1730} = 6{\cdot}51$ "

Another method is to make the area of the coupe inversely proportional to the estimated relative quality of the station.

In the above example, for instance, if the quality of the best station, say No. 2, is taken as a standard of comparison, and represented by unity, of No. 1 by ·9, and of No. 3 by ·7, we should have

65 acres giving each the full yield of	65	standard acres.	
50 " giving ·9 of the full yield, or the equivalent of only ...	45	"	"
45 acres giving ·7 of the full yield, or the equivalent of only ...	31·5	"	"
Total equivalent to ...	141·5	"	"

For a revolution of 30 years the coupe must, therefore, be equal to a standard coupe of

$$\frac{141{\cdot}5}{30} = 4{\cdot}72 \text{ acres,}$$

and in No. 1 compartment the size of the coupe would be

$$\frac{4{\cdot}72}{{\cdot}9} = 5{\cdot}24 \text{ acres;}$$

in No. 2 compartment $\frac{4{\cdot}72}{1{\cdot}0} = 4{\cdot}72$ "

and in No. 3 compartment $\frac{4{\cdot}72}{{\cdot}7} = 6{\cdot}74$ "

Supposing the data of the estimate to be correct, the former method would give a uniform yield during the revolution, but would not bring about the ideal state at the end. This object would be attained by the latter method at the cost of more or less irregular yields during the revolution. The plan, however, which is usually adopted, and which answers all practical purposes in *coppice-forest*, is to consider the yearly coupe equal to $\frac{A}{r}$; the cuttings in that case can be equalised, if necessary, by taking a little more here or a little less there, when it is found that the yield is above or below the average.

The *annual coupes are sometimes marked off on the map, and* are demarcated on the ground by means of stones, or other

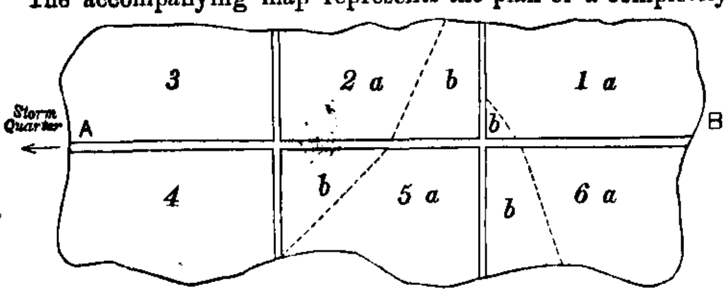
boundary-marks ; but, for the following reasons, it is better not to do so. (1), if the demarcation is carried out in the forest, and any alterations are subsequently made in the area of the series, the original demarcation will no longer hold good ; (2), if the productive power of the station varies considerably on a coupe, it may be desirable to compensate for such variations from time to time by exploiting a somewhat larger, or smaller, area than the normal, according to circumstances ; but this could not be done if each annual coupe were marked off beforehand ; (3), the expense ; (4), it prevents any change in the length of the revolution.

This method of determining the annual yield can only be employed in the case of coppice-forests, which, owing to their short revolutions and mode of regeneration, are much less liable to considerable fluctuations of yield, delays in re-stocking, and dangers from natural causes.

Its unsuitability to seedling-forest will be quite clear from the following considerations. The yield from a good station may easily amount to double that of a bad station in a forest subject to a revolution of only 100 years, and, as it would not generally answer in extensive forests to cut twice as much one year as was cut during another, it would be necessary in such cases to have coupes inversely proportional to their estimated power of production ; but such estimates for long periods are of little value. Again, in forests naturally regenerated by seed, trees are only gradually removed and several coupes would have to be taken in hand at the same time, which would virtually amount to adopting a totally different system. Damage by insects is another possible cause of alterations in the original plan : groups may thereby be killed outright, or so injured that it is necessary to regenerate them at once. The same result may be brought about by snow, fire, and wind which often cause great havoc in groups that have reached, or passed, the sapling-stage.

Example of the Determination of the Annual Yield by the Method of equal annual areas.

The accompanying map represents the plan of a completely-



stocked seedling-forest of teak of 360 acres, which is to be converted into coppice with a revolution of 30 years.

The area consists of two independent blocks, separated by the main ride (AB), and is divided into six compartments, of 60 acres each, containing the following groups :—

1*a*,	56	acres,	group	25	years old.
1*b*,	4	„	„	5	„
2*a*,	40	„	„	15	„
2*b*,	20	„	„	5	„
3,	60	„	„	35	„
4,	60	„	„	35	„
5*a*,	40	„	„	27	„
b,	20	„	„	15	„
6*a*,	36	„	„	5	„
b,	24	„	„	31	„

It is found by experimental cuttings that the yield is as follows :—

Average Yield per Acre.

Age of group.	Cubic contents, feet.	Average yearly growth, feet.
15	725	48
20	1,300	65
25	1,750	70
30	2,100	70
35	2,380	68
40	2,600	65
45	2,880	64

The annual coupe will amount to $\frac{360}{30} = 12$ acres. For the sake of shortness, we will divide the whole into three periods of 10 years each, comprising $12 \times 10 = 120$ acres each. The *reader can easily imagine each of these 120 acre-plots split up into the annual coupes of 12 acres each.*

The stormy quarter being on the left, the cuttings should progress from right to left.*

The compartments most suitable for the first period, having regard to the age of the groups they contain, are numbers 3 and 4, of 60 acres each, with groups 35 years old. As the adjacent groups in 2*a* and 5*b* are only 15 years old, there appears to be no objection to exposing these by cutting away the older groups

* This rule is rigorously applicable only to seedling-forest; in coppice-forest, little is to be feared from storms, and an arrangement of cuttings, which affords protection to the young growth from sun or dry winds will often be of more importance.

in front of them. We should then have the following yield and coupes *for the first period*:—

Compartment.	Present age of group.	Average age of group at time of cutting.	Area of compartment or sub-compartment.	Yield per acre, cubic feet.	Total yield of group.	Yield of 1st period 1886-95.	Mean yearly yield.
4	35	40	60	2,600	156,000	312,000	31,200
3	35	40	60	2,600	156,000		

At the end of the first period the oldest groups remaining will be

6b, of 24 acres, with group 41 years old.
5a, " 40 " " 37 "
1a, " 56 " " 35 "

The groups in *6a*, behind *6b*, being only 15 years old, there is no objection to the older group being cut. *1a* may evidently be cut, and after the removal of *6b*, *5a* may also be cut. For the second period, we would then have the following *yield and coupes*:—

Compartment.	Age of group at beginning of the period.	Average age of group at time *of cutting*.	Area of coupes.	Yield per acre.	Total yield.	Yield of second period.	Average annual yield per *annum*.
			Acres.	Feet.		Cubic ft.	Feet.
6b	41	46	24	2,944	70,856	...	...
5a	37	42	40	2,730	1,09,200	3,25,456	32,546
1a	35	40	56	2,600	1,45,600	...	...

For the third period we would have remaining

2b, of 20 acres, with group 25 years old.
2a, " 40 " " 35 "
5b, " 20 " " 35 "
6a, " 36 " " 25 "
1b, " 4 " " 25 "

These might be worked in the order named, without any danger to standing-stock. The yield would then be

Compartment.	Age of group at beginning of period.	Average age of group at time of cutting.	Area of coupes.	Yield per acre.	Total yield.	Yield of third period.	Average yield per annum.
			Acres.	Feet.		Cubic ft.	Feet.
2*b*	25	30	20	2,100	42,000	...	...
2*a*	35	40	40	2,600	1,04,000	...	...
5*b*	35	40	20	2,600	52,000	2,82,000	28,200
6*a*	25	30	36	2,100	75,600	...	...
1*b*	25	30	4	2,100	8,400	...	...

At the end of the revolution the oldest group would be 30 years of age, and the average age of the groups to be cut during the following period would be 25 years. During the next revolution, therefore, the sub-compartments might be got rid of, if desired, without much loss; 40 acres stocked with groups averaging 20 years of age instead of 30 would have to be entered in the first period; on the other hand, two-thirds of the groups in five, occupying 40 acres, would have to be cut at an average age of 40 years. Supposing the relative production to be the same as before, the yield for the second revolution would then be :—

Period.	Compartment.	Age at beginning of period.	Average age of groups at time of cutting.	Area of compartment or sub-compartment.	Yield per acre, feet.	Total yield of group.	Yield of period.	Mean yearly yield.
I.	3	25	30	60	2,100	1,26,000	2,52,000	25,200
	4	25	30	60	2,100	1,26,000		
II.	1*a*	25	30	56	2,100	1,17,600	2,20,000	22,000
	b	15	20	4	1,300	5,200		
	6*a*	15	20	36	1,300	46,800		
	b	25	30	24	2,100	50,400		
III.	5*a*	35	40	40	2,600	1,04,000	2,72,000	27,200
	b	25	30	20	2,100	42,000		
	2*b*	25	30	20	2,100	42,000		
	a	25	30	40	2,100	84,000		

The yield after the second revolution would then be uniform for each period, namely, 2,52,000 cubic feet, yielding an annual income of 25,200 cubic feet.

(To be continued).

BUTEA FRONDOSA.

CAN the Editor of the "Indian Forester" or any of its readers inform me whether a variety of palás (*Butea frondosa*) in no way differing from the ordinary tree, except in the colour of the flower,* a pale yellow, is common in any part of India? I have lately come across a few specimens, and find no mention of the variety in Brandis' work.

K.

MALE FLOWERS OF DEODAR.

I SEND two catkins which I have to-day observed; these appear to be at least a week old, so that the date of earliest appearance varies in different years. Last year it was 26th June (as already reported in the "Forester"), this year it must have been about the 13th. Will other officers correct any errors in my table from time to time?

J. C. McD.

STEEL SLEEPERS.

THE French Government has hit upon an altogether unexceptionable method of encouraging the native iron and steel trades. It has been determined to discard the use of wooden sleepers on the State railways, and to gradually substitute the metal ones which are coming into extensive use on the Continent, as in India and our Colonies. In Germany they are in high favour, since, although the first cost is greater, they are found to be more durable than wooden ones. The Minister of Commerce is inviting tenders for 25,000 steel sleepers to begin with; but it is calculated that 4,300,000 of them will be required every year for fifteen years before the whole of the existing mileage will be replaced. At present prices this means an expenditure of £1,600,000 per annum upon steel: a prospect which will range a good many people on the side of the present Government. We do not know that any fair trial of metal sleepers, whether of iron or steel, has yet been made in England; but in the melancholy position of our iron trade, it is very desirable that some experiments should be made. It is almost inevitable that within twenty years metal will be exclusively used for this purpose, since the timber supply of the world is being rapidly exhausted. The American forests, indeed, will probably not last another twenty years.—*St. James Gazette.*

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* Varieties in colour of flowers of the same species frequently occur. If "K" would kindly send well preserved specimens to the Forest School Museum, we should be much obliged.—[ED.]

III. Notes, Queries and Extracts.

Bird-murder.—A very urgent appeal to the public has just been issued in America by our contemporary *Science*, which journal has attached to its issue of February 26 a special "Supplement" devoted to the question of "the present wholesale destruction of bird-life in the United States." Powerful articles have been written by Messrs. J. A. Allen, W. Dutcher, and G. B. Sennett, three prominent American ornithologists, in which the facts have been plainly set forward, remedial legislation proposed, ending with an "appeal to the women of the country on behalf of the birds."

The American Ornithologists' Union has also appointed a "Committee on Bird-Protection," and from the names of the gentlemen who are serving on it, it is quite certain that practical remedies will be forced on the consideration of the American people, and that energetic efforts will be made to preserve the birds from destruction. But it is equally certain that a corresponding effort must be made by civilised nations on this side of the water, if remedial measures are to have a real effect, and we are glad to find that steps are being taken to attract public attention to the gross scandal which now exists in our midst. A "Selborne Society" has been formed, of which Mr. G. A. Musgrave, of 45, Holland Park, is the secretary, and of which H. R. H. Princess Christian is a patron, for the protection of birds. Invoking the shade of the gentle Gilbert White of Selborne, this Society may hope to prevail somewhat with the English nation, which would undoubtedly protest with the same vehemence on behalf of the small songsters of England, as it did some years ago on behalf of the sea-birds, if the facts are but put plainly forward. We are certain that if the women of this country only knew the real state of the case, the senseless and savage decorations now in vogue would be regarded with disgust and loathing. The Selborne Society has but just commenced its labours, but already many excellent well-wishers have joined it, and it numbers amongst its members many names famous in society, in art, in literature, and in science.

There is scarcely a portion of the world which is not being devastated of its birds at the present moment to minister to the fashionable wants of the women of Europe and America, and it is as well that the root of the evil should be recognised at once. This has been done in America, and the point must be insisted

on again and again in this country, that the vanity of womankind is in this enlightened age the cause of the "wholesale destruction of bird-life" on this side of the Atlantic as much as in America. Nor is it confined to the higher classes. The difference between the factory-girl and the high-born lady as regards the question of bird-feather decoration is only one of degree, the former paying as many halfpence for the starling's wing in its natural state as the latter does in shillings for the same article dyed or gilt out of recognition as it may be. New Guinea and the Papuan Islands are being despoiled of the birds of paradise, India and Africa of their sun-birds and rollers, Southern Europe of its bee-eaters, until every one of these countries is being exhausted of its feathered denizens. It is no longer the brightly-plumaged species which are being laid under contribution, for, as exhaustion has begun to limit the supply, the soberly-clad birds are now being shot down in thousands to minister to "fashion" in this country. Thus any one with a knowledge of birds has only to walk down any fashionable thoroughfare in London, and note the materials with which the bulk of the hats in the milliners' shops are decorated, to see that robins, sparrows, larks, and starlings are a staple commodity with the trade in this country. Dyed they are in most cases, and occasionally relieved by the wings of some Indian "jay" (*i. e.*, roller), or African "merle" (glossy starling) or sun-bird, or it may be with a few "osprey" feathers. These last are the long breeding-plumes of the egrets, which are developed only during the nesting season, and the slaughter amongst these birds at that time of the year must be something incredible. No wonder that Mr. Allen complains that the "swamps and marshes of Florida have been depopulated of their egrets and herons." It is not as if the birds thus slaughtered were harmful, the killing of them beneficial. On the contrary, the majority of the species now massacred are distinctly beneficial to the countries they inhabit, and surely no one could wish that this country should be deprived of its birds and reduced to the generally unaviferous aspect of France and Italy.

It is said that legislation in the direction of the further protection of birds would be an interference with the legitimate industry of the "plume" trade. This is by no means the case. There are many birds which are used as articles of food, the plumage of which could be utilised for decorative purposes; and that this is well known by the trade is evidenced by the large number of dyed fowls' wings which figure largely in the composition of hat and bonnet ornament. Just as before, when the outcry against the slaughter of gulls and sea-birds rendered the wearing of their feathers unfashionable, the milliners adapted their wares to the wants of their customers, so would they once more find substitutes for the larks, robins, and other small birds which they now use by the thousand.

Our American brethren have put forward some practical suggestions with regard to a stoppage of the traffic. Mr. Allen shows that in the natural order of things birds have already sufficient enemies to contend against without having the hand of man turned against them too. Vast numbers perish in the eggs, which are the food of many predatory animals, and numbers perish while yet too young to defend themselves against their enemies. To stress of weather also and the trials of migration large quantities of birds succumb, and a severe winter like the last one causes the death of birds of all classes alike. On the top of all these ills which ornithological flesh is heir to, comes a blood-thirsty demand from the women of civilised nations for their small bodies to adorn hats or ball-dresses—in order that our belles may not leave the monopoly of feather ornamentation to savages. Statistics have not been published giving an exact account of the number of birds annually sold in London by auction for the plume trade, but it is well known that the numbers are enormous. Thirty thousand ruby-and-topaz humming-birds are said to have been sold some years ago in the course of an afternoon, and the number of West Indian and Brazilian birds sold by one auction-room in London during the four months ending April 1885, was 404,464, besides 356,389 Indian birds, without counting thousands of Impeyan pheasants, birds of paradise, &c. In Mr. Dutcher's article on the "Destruction of Birds for Millinery Purposes," he quotes from an article in *Forest and Stream*, wherein one dealer, during a three months' trip to South Carolina, prepared no less than 11,000 skins. "A considerable number of the birds were, of course, too much mutilated for preparation, so that the total number of the slain would be much greater than the number given. The person referred to states that he handles, on an average, 30,000 skins per annum, of which the greater part are cut up for millinery purposes." During four months 70,000 birds were supplied to New York dealers from a single village on Long Island, and an enterprising woman from New York contracted with a Paris millinery firm to deliver during this summer 40,000 or more skins of birds at 40 cents apiece. From Cape Cod, one of the haunts of the terns and gulls, 40,000 of the former birds were killed in a single season, so that "at points where, a few years since, these beautiful birds filled the air with their graceful forms and snowy plumage, only a few pairs now remain." The above extracts out of many interesting facts which could be quoted from the articles in *Science*, give some idea of the slaughter which is going on at the present time, and it is to be hoped that some *immediate* steps may be taken to call public attention to this wholesale bird-murder, before the nesting season begins, when most of the mischief is done among the sea-birds which congregate in large numbers at that time of year.

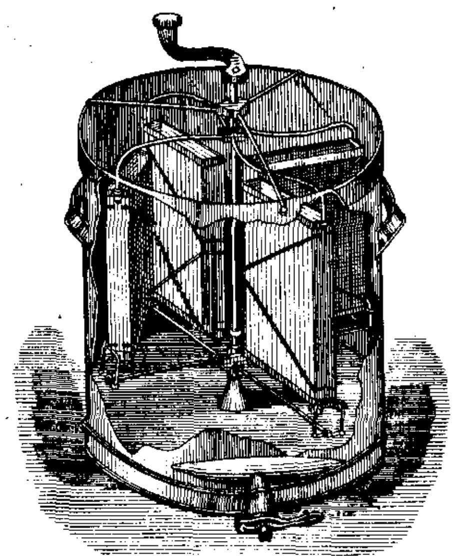
Space does not permit us to traverse the whole of the ground taken up by our contemporary, whose articles occupy fifteen pages, but we trust that they will be perused by our readers for themselves. Mr. Sennett's essay on the "Destruction of the Eggs of Birds for Food" proves the wanton waste which accompanies the ways of the professional "egger," to say nothing of the cruelty which accompanies the taking of the eggs. The "Relation of Birds to Agriculture" is a well-written article, as is also an essay on "Bird-Laws," the latter containing resolutions which, if adopted by the Legislature, would undoubtedly prove of great service in protecting bird-life on both sides of the water, but no legislation will avail unless the women of America and Europe can be made to understand that they are absolutely responsible for the wholesale destruction of birds which is now going on, to the great benefit of the plume trade and the milliners, but to the everlasting detriment of the world on which we live. We should like to see some authorised body, such as the British Ornithologists' Union, the Selborne Society, or a Committee of the British Association, taking this matter in hand and organising public meetings to bring the true facts of bird-slaughter before the public; and we have every faith in the good sense of English women to secure a stoppage of the trade which exists by their patronage alone, and which is thoroughly antagonistic to the instincts of humanity.—R. BOWDLER SHARPE.—*Nature.*

EXTRACTING HONEY.—Since the invention of the Movable Comb Hive, there has been none made so valuable to bee-keepers, as the machine for throwing honey from the combs by centrifugal force, called the "Honey Extractor." This was invented about the year 1868, by Herr Hurschka, of Germany. It consists of a tin can, inside of which is a central upright shaft, which is made to revolve with great rapidity by means of a crank and gearing. The shaft carries a reel, or a set of comb baskets to hold the comb while it is being extracted. When the combs are filled with honey, they are to be taken from the hives, and the adhering bees shaken and brushed from them. With a knife made for the purpose (*Fig.* 1), the cappings of the cells are shaved off, and the combs placed in the comb baskets within the extractor. The combs are then revolved rapidly enough to throw the honey from the cells. After the cells upon one side of the comb are emptied, the motion of the machine is reversed. The comb baskets are so arranged that they will reverse also, and allow the other side of the comb to be emptied. A faucet or molasses gate, is arranged at the bottom of the can, to draw out the honey as it accumulates. After the combs are emptied, they

Fig. 1.—HONEY KNIFE.

are returned to the hives to be refilled by the bees. Since the original honey extractor, numerous improvements have been made in its construction, and there are now several different kinds offered to bee-keepers. The extractor illustrated in *Fig.* 2, is known as the "Stanley," which presents many manifest improvements, especially that which allows the combs to be reversed within the can. Previously it had been necessary to take

Fig. 2.—CENTRIFUGAL HONEY EXTRACTOR.



the combs out of the can, and turn them, in order to empty the cells on the opposite side.

I have combs now in use, and in perfect condition, which have been emptied several times each season for fifteen consecutive years. Before the invention of the honey extractor, liquid or strained honey was secured by crushing the combs and straining the honey through a thin cloth. In this way it contained pollen and other impurities, and the bee-keeper likewise sustained great loss in the destruction of the combs. With the use of the *extractor, the honey only* is removed, free from all impurities, and the combs are uninjured. Partly filled sections, and pieces of white comb, may have the honey taken from them, and then be laid away for another season's use.

Another very important advantage in the use of the extractor, is that each quality of honey may be secured separately. As soon as the yield of honey from any particular honey-producing plant is over, the combs may be entirely emptied, and be ready to receive the honey from flowers that bloom next in

succession. In this way, light and dark grades of honey may be kept unmixed.—*American Agriculturist.*

TROPICAL DEW.—Having had occasion to lay out a large quantity of iron hoes and picks, without handles, on the hard ground of an open inclosure in one of the driest districts in India (Bellary), where in fact these implements had been collected in the face of a scarcity, it was found, after they had lain a couple of months, that a thick, weedy, but luxuriant vegetation had sprung up, enough, though there had been no rain, to almost hide the tools. The effect depositing tools on grass has had in stimulating its growing the writer has observed in the tropics before, but was at a loss to account for it, except upon some irresolvable theory of radiation or magnetism.

The whole phenomenon is cleared up by Mr. Aitken's paper on "Dew" in "Nature" of January 14 (page 256), dew being proved deposited, not, as generally thought, from the air above, but rising and condensing from the soil below; and the ground in India is always hygroscopic. The outer surfaces of the iron tools radiate of course quickly at night, and the stratum of air inclosed between the metal under surfaces and the earth is, therefore, saturated with condensing moisture. That iron gratings laid on bare ground will raise a rank vegetation in places with only 10 or 15 inches of annual rain fall, and exposed to tropical heat, is a not unimportant fact, as being a readily available substitute for irrigation water, worth further investigation.—*Nature.*

MR. E. W. D. HOOPER, of the Madras Forest Department, is at present on a visit to Jamaica, having been deputed by the Secretary of State to inquire into the effects of deforestation in the West Indian Colonies.

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FOREST ORGANIZATION FOR BEGINNERS.

(Continued from page 298).

SECTION IV.—*(continued)*.

CHAPTER VI.—*continued.*

2. METHOD OF PERIODIC AREAS.

By massing together several annual coupes in the example, just given, of the method of equal annual areas, we have in a measure anticipated the description of this system, although the reader was warned that each periodic area was to be imagined split up into ten annual coupes. The difference between the two is indeed not very great. By the method of equal periodic areas, the annual coupes during a period (usually 10—30; at most 40) are taken together and called collectively a *periodic area.* These periodic areas, or *affectations*, as they are sometimes called, are designated first, second, third, according as they belong to the first, second, or third period of the revolution, and so on. Supposing that a forest of 1,200 acres, is subjected to a revolution of 120 years with periods of 20 years (which is the term generally chosen for seedling-forest), there would then be

$$\text{an annual coupe of } \frac{1200}{120} = 10 \text{ acres, and}$$

$$\text{periodic areas of } 10 \times 20 = 200 \text{ acres each.}$$

There would be six such periodic areas, and, if the age-classes were complete, the first would comprise all trees 101—120 years old, in equal proportions; the second, all 81—100; and so on down to the last stocked with trees 1—20 years old.

There are two forms of this method. According to the older one, each compartment of the series is allotted to a certain periodic area, and is shown on the map as belonging to one particular affectation. In the diagram, at page 339, for instance, which represents a forest of 540 acres, divided into two blocks, each containing three compartments, if the revolution of

2 x

the series be 90 years, each compartment should, according to this form of the method, be devoted to one particular affectation, and may consist of, say, 30 annual coupes. Supposing that the stormy quarter is on the left-hand, compartments 1, 2 and 3, in one block, and 6, 5, and 4 in the other, may be respectively allotted to the first, second, and third affectations. Or, number 2 might be allotted to the first, number 3 to the second, and number 1 to the third; or, again, number 3 might be put first, number 1 second, and number 2 third; the disposition depending on which is the most suitable arrangement in order that the groups may be exploited most advantageously. Similar alternative dispositions might be made in the other block.

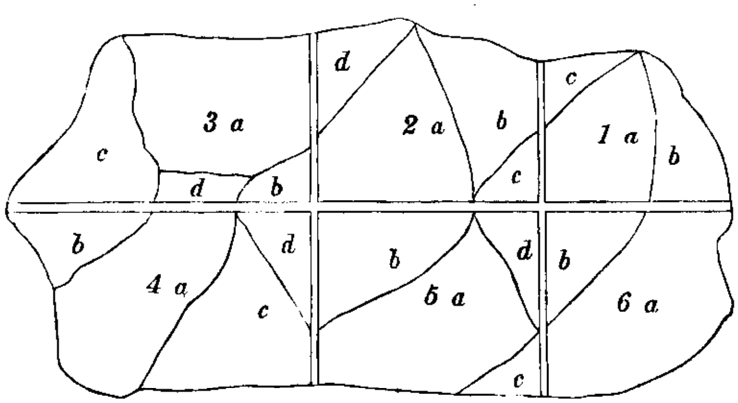
By the more modern system, a compartment is not necessarily allotted wholly to one particular affectation, but may be split up into portions belonging to different periodic areas. At the present day, there is very little real difference between these two forms, because the most enthusiastic advocate of a good sequence of cuttings would never now dream of confining the coupes during a period to one particular compartment of a block unless the age-classes harmonised fairly well with such an arrangement; but, at one period of the history of organization, great sacrifices used to be made to effect a good sequence, very young groups being often cut away, and old ones left standing long beyond their proper term, in order to attain this object. Now-a-days, therefore, the marking-off of affectations on the map, or in the forest, in series in which the age-classes are very irregular, has lost all meaning, and could at most serve to emphasize the state which it is desired to bring about sooner or later; in other respects, however, it is worse than useless in such cases, as it does not show the actual periodic areas, which may be scattered about all over the series, as is the case in the example which follows. A plan of exploitation for very irregular forest is generally considered satisfactory if it enables the manager to cut, in each period, the groups most suitable for exploitation during such period, without detriment or danger to those left standing.

Apart from the considerations already noted, it seems to be quite possible to carry the mania for establishing a whole series of coupes, one behind the other, to excess, as, for instance—to take an extreme case—when a large forest is exploited by means of only one coupe yearly, and the coupes proceed in regular order, one behind the other, the forest rising up, step-like, from the one-year-old to the oldest group. In such a case, the good old rule, that a coupe adjoining an old one should not be made until the young growth on that immediately behind it is established, could not be applied. And, if fire got into a long row of coniferous thickets, what a blaze there would be! Whereas, when the sequence of young groups is broken by older groups, fire is much more easily arrested. Again, when forests have been seriously attacked by insects, interrupted age-classes have often been found very useful in arresting the spread of the evil.

Very great regularity over a large area may, therefore, often turn out to be a serious obstacle to good management. The alternative is, numerous comparatively-small blocks, in which cuttings can be easily regulated so as to meet the exigencies of sylviculture as well as of good sequences. The numerous advantages derivable from small blocks must at once be apparent to everyone. Take, for instance, the case of a plantation attacked by the beetle *Hylobius abietis:* cuttings might be immediately stopped in the block attacked and not resumed until the beetle had disappeared. Or, take the case of a failure of young seedlings in a group to be naturally regenerated, or in a young plantation ; further cuttings in the sequence of the block could be easily postponed, if necessary, until regeneration had been effected on the area of failure. But, in a forest consisting of one large block—to take an extreme case—interruptions to the sequence might not be feasible : at least, the drawbacks to breaking the sequence might outweigh any possible advantages of resorting to it, as, for instance, when suitable intermediate cuttings could not be effected without exposing old groups to dangerous winds.

Example of the determination of the yield by the method of periodic areas.

The accompanying diagram represents a seedling-forest of 540 acres, subject to a revolution of 60 years with periods of 20 years each, and stocked with the following groups :—



1*a*	of	30	acres,	group	80	years old.
b	„	20	„	„	21	„
c	„	12	„	„	15	„
2*a*	„	45	„	„	30	„
b	„	31	„	„	15	„
c	„	10	„	„	80	„
d	„	15	„	„	65	„
3*a*	„	56	„	„	65	„

3*b*	of	8	acres,	group	30	years old.
c	„	37	„	„	5	„
d	„	7	„	„	45	„
4*a*	„	43	„	„	45	„
b	„	14	„	„	55	„
c	„	33	„	„	10	„
d	„	14	„	„	30	„
5*a*	„	55	„	„	10	„
b	„	30	„	„	30	„
c	„	11	„	„	blank	
d	„	13	„	„	5	„
6*a*	„	42	„	„	21	„
b	„	14	„	„	80	„
		540				

For the sake of shortness, the revolution is taken as 60 years only. For the same reason, the compartments are assumed to be fully stocked and of uniform fertility, yielding the following returns per acre.

Age of group.	Yield per acre, cubic yards.	Age of group.	Yield per acre, cubic yards.
5	1	60	276
10	3	65	300
15	19	70	322
20	37	75	343
25	60	80	364
30	96	85	385
35	120	90	404
40	158	95	422
45	204	100	441
50	225	105	457
55	252	110	460

The object desired is to combine the cutting of the most mature groups first, and the establishment of sequences in each block, so that numbers 1 and 6 shall be exploited in their respective blocks before numbers 2 and 5, and the latter before 3 and 4: further, it is desirable so to organize the cuttings that those in each compartment shall proceed in regular order from right to left. In such irregular forest, all these objects can not be attained, so that if a regular sequence is to be effected, some groups must evidently be exploited before, and some after, maturity. For groups thus situated, the question may be whether it is, on the whole, advisable to sacrifice an immature, but still marketable, group—there can be no doubt as to the proper course to pursue in regard to groups which are not marketable—and thus secure a good sequence, or if it is preferable to leave it standing until the proper term has been reached, or until the

cuttings naturally again come round to the same spot, thereby postponing indefinitely the establishment of a regular sequence. Or, it may be a question of holding-over a mature group until the sequence reaches it in due course.

Questions of sylviculture, of immediate or prospective yield, of increment and general growth, and many other considerations, may sometimes incline the balance in favour of exploitation, sometimes in favour of retention; but as the decision depends entirely on arbitrary judgment, various schemes are evidently practicable, all perhaps equally justifiable and good, of which the following is one.

The area of the series being 540 acres and the revolution 60 years, the annual coupe is $540 \div 60 = 9$ acres; and, a period being of 20 years' duration, each affectation is $9 \times 20 = 180$ acres in extent.

1st Affectation.

Sub-compartment.	Present age of group.	Age at time of exploitation.	Area, acres.	Yield, cubic yards.	Remarks.
1*a*, ...	80	90	30	12,120	
2*c*, ...	80	90	10	4,040	
6*b*, ...	80	90	14	5,656	
2*d*, ...	65	75	15	5,145	
3*a*, ...	65	75	56	19,208	
4*a*, ...	45	55	43	10,836	
4*b* (part), ...	55	65	12	3,600	
Total, ...	...	...	180	60,605	

2nd Affectation.

Sub-compartment.	Present age of group.	Age at time of cutting.	Area, acres.	Yield, cubic yards.	Remarks.
3*c* (part), ...	5	35	2	240	Safety-cutting along border of 3*a*.
4*b* (remainder),	55	85	2	770	
3*d*, ...	45	75	7	2,401	
1*c*, ...	15	45	12	2,448	
2*a*, ...	30	60	45	12,420	
5*b*, ...	30	60	30	8,280	
4*d*, ...	30	60	14	3,864	
3*b*, ...	30	60	8	2,208	
1*b*, ...	21	51	20	4,584	
2*b*, ...	15	45	31	6,324	
6*a* (part), ...	21	51	9	2,063	
Total, ...	...	...	180	45,602	

3rd Affectation.

Sub-compartment.	Present age of group.	Age at time of cutting.	Area, acres.	Yield, cubic yards.	Remarks.
6*a* (remainder),	21	71	33	10,771	
3*c* (remainder),	5	55	35	8,820	
5*c*, ...	0	50	11	2,475	
6*b*, ...	80	40	14	2,212	Second time during the revolution.
5*d*, ...	5	55	13	3,276	
5*a*, ...	10	60	55	15,180	
4*c* (part), ...	10	60	19	5,244	
Total, ...	...	...	180	47,978	

It is assumed that the blank in 5*c* is afforested at the beginning of the revolution.

Safety-cuttings consist in clearings 30, or more, feet broad, made on the weather-side of a group when it is young, to enable it to withstand, when older, the sudden exposure caused by the cutting of the group immediately in front of it. If the area cleared is not re-stocked, the additional light and space causes the trees on the margin to develope stronger roots and lower branches, and so to resist the storm and afford a protecting shelter to the trees behind. If the area is re-stocked, the young group forms an effective wind-break. The safety-cutting in the second period is necessary to protect the group in 3*a* when the trees in 3*c* are cut during the third period.

The average age of a group of the first period is found by adding to its present age 10 years (half a period); that of a group of the second period by adding 30 years; and that of one of the third period by adding 50 years. In this manner the average age of exploitation is obtained with sufficient accuracy, as it is impossible to foresee the exact year in which a group will be cut. At the same time, by a little management, groups put down for cutting before their proper term can often be kept till nearly the end of the period, so as to give them a few years additional growth; and over-mature groups may often be exploited at the beginning of the period. By cutting 6*b*, for example, at the very commencement of the first period—which is quite feasible and desirable, too, for several reasons—and by keeping the fresh crop standing until the very end of the revolution—which would be quite practicable if the proposed order of cuttings were not disturbed by unforeseen occurrences—the fresh growth would have attained an age of 55 or more before being cut, instead of 40.

At the end of the revolution, even if everything went on without a hitch, the age-classes and sequences would be far from perfect ; but by the end of the second revolution, regular age-classes and a good sequence of cuttings might be established in the following manner without much loss, supposing that nothing occurred to alter the plan :—

1st Affectation.

Sub-compartment.	Area.	Age of group.
1*a*,	30	60
5*b*,	30	40
4*d*,	14	40
4*c* (part),	7	80
4*a*,	43	60
4*b* (part),	12	60
b (part),	2	40
1*b*,	20	40
1*c*,	12	40
2*c*,	10	60
Total, ...	180	

2nd Affectation.

Sub-compartment.	Area.	Age of group.
2*b*,	31	60
2*a*,	45	60
2*d*,	15	80
3*a*,	56	80
3*b*,	8	60
3*d*,	7	60
3*c* (part),	2	60
3*c* (part),	16	40
Total. ...	180	

3rd Affectation.

Sub-compartment.	Area.	Age of group.
3*c*,	19	60
6*a*,	42	60
6*b*,	14	60
5*c*,	11	60
5*d*,	13	60
5*a*,	55	60
5*b*,	26	40
Total, ...	180	

This method is preferable to that of equal annual areas, because it allows the executive to choose, within certain necessary limits, which groups shall be exploited from year to year, thereby affording full scope for the exercise of the manager's judgment in selecting groups for regeneration. In other respects, as regards seedling-forests, it would appear to have all the disadvantages of the older system, notably that, since the annual yield is regulated solely by area, great fluctuations may occur from year to year, more particularly in irregular forests and those subject to long revolutions, thus perhaps upsetting the

market for the produce and causing inconvenience and loss to the proprietor and the public. It is evidently inapplicable to natural regeneration by seed, which can not be effected by making a clean sweep of the trees on the annual coupe.

3. Hartig's Method.

In order to avoid some of the inconveniences arising from the methods of area when applied to seedling-forests, Hartig struck out quite a new line. He discarded altogether the area of the forest as regulator of the yield, basing his calculations on the estimated contents and increment of the whole forest. His method consists in estimating the contents and increment of the whole forest, dividing the revolution into periods, and so arranging the cuttings that the same quantity of estimated material shall be cut in each period, and the whole forest cut over during one revolution. *The method is very simple, and* will be easily understood by means of the following example:—

Example of Hartig's Method.

We will take, for this purpose, the forest of 540 acres described at page 339. As in the last example, the revolution is 60 years with three periods of 20 years each, and the following yields :—

Age of group.	Yield per acre.	Age of group.	Yield per acre.
Years.	Cubic yards.	Years.	Cubic yards.
5	1	60	276
10	3	65	300
15	19	70	322
20	37	75	343
25	60	80	364
30	96	85	385
35	120	90	404
40	158	95	422
45	240	100	441
50	225	105	457
55	252	110	460

The first step to take is to ascertain the quantity of standing-stock immediately available. Taking groups in the same order as in the last example, we should have the following capital-stock and average yearly increment:—

Sub-compartment.	Area, acres.	Age of group.	Contents of group, cubic yards.	Yearly increment of group, cubic yards.
1*a*	30	80	10,920	136
2*c*	10	80	3,640	45
6*b*	14	80	5,096	63
2*d*	15	65	4,500	69
3*a*	56	65	16,800	258
4*a*	43	45	8,772	195
4*b*	14	55	3,528	64
3*c*	37	5	37	7
3*d*	7	45	1,428	32
1*c*	12	15	228	15
2*a*	45	30	4,320	144
5*b*	30	30	2,880	96
4*d*	14	30	1,344	45
3*b*	8	30	768	25
1*b*	20	21	740	35
2*b*	31	15	589	39
6*a*	42	21	1,722	82
5*c*	11	0	...	...
6*b*	14	80	5,096	64
5*d*	18	5	13	3
5*a*	55	10	165	17
4*c*	33	10	99	10
Total,	...	...	72,685	1,444

The total contents of the forest being 72,685 cubic yards, and the revolution 60 years, we ought to be able to cut annually at least 72,685 ÷ 60 = 1,211 cubic yards, together with the average increment on the standing stock of the present forest during the revolution. This increment would, roughly speaking, decrease in an arithmetical progression, so that during the first year there would be an increment on $\frac{59}{60}$ of the whole forest, amounting to an increase of 1,420 cubic yards; during the second year, there would be $\frac{1}{60}$ less, during the third $\frac{2}{60}$ less, and so down to the last year, when there would be the increment on $\frac{1}{60}$ of the whole forest, or 1,444 ÷ 60 = 24 cubic feet. Roughly speaking, we may, therefore, say that there would be during the revolution an increment on the old stock of $(1,420 + 24)\ \frac{60}{2} = 43,320$ cubic yards. On this basis, the

total annual yield would amount to $1{,}211 + \frac{43320}{60} = 1{,}211 + 722 = 1{,}933$ cubic yards; and the yield for a period would be $1{,}933 \times 20 = 38{,}660$ cubic yards.

Strictly speaking, the calculation should be made with a view to exploiting the whole of the forest during the present revolution; as, however, it would be decidedly bad management from a sylvicultural point of view to cut 4*a* before 5*a* is completely exploited, 14 acres of the former are left for the first period of the second revolution, and a corresponding area obtained by cutting 6*b* twice during the present revolution.

If the forest were normally constituted, there would be 180 acres of each age-class; the actual state is, however, as follows:—

groups	1—20	years old	occupying	192	acres.
"	21—40	" "	"	159	"
"	41—60	and over	"	189	"

Amongst the last there is a great quantity of over-mature wood 80 years old, and this surplus is not likely to be compensated by the deficiency in groups of the second category. It is, therefore, pretty certain that the capability of the forest is in excess of the above estimate of 38,660 cubic yards for each period. How much more, or less, it may be, can only be known by actual experiment. We might, therefore, commence by trying a yield of 45,000 yards, and then gradually equalize the periodic yields by transposing groups from one period to another until a tolerably uniform result, such as the following, should be obtained.

No thinnings are taken into account in this example: if any are available, their estimated average yield would have to be added in order to give the full return.

1st Period.

Sub-compartment.	Area, acres.	Average age of exploitation.	Yield of group per acre, cubic yards.	Total yield of group.
1*a*, ...	30	90	404	12,120
2*c*, ...	10	90	404	4,040
6*b*, ...	14	90	404	5,656
2*d*, ...	15	75	343	5,145
3*a*, ...	56	75	343	19,208
4*a* (part of),	25	55	252	6,300
Total, ...	150	...	...	52,469

2nd Period.

Sub-compartment.	Area, acres.	Average age of exploitation.	Yield of group per acre, cubic yards.	Total yield of group per acre, cubic yards.
Remainder of 4*a*,	18	75	343	6,174
4*b*, ...	14	85	385	5,390
3*c* (part), ...	2	35	120	240
3*d*, ...	7	75	343	2,401
1*c*, ...	12	45	204	2,448
2*a*, ...	45	60	276	12,420
5*b*, ...	30	60	276	8,280
4*d*, ...	14	60	276	3,864
3*b*, ...	8	60	276	2,208
1*b*, ...	20	51	229	4,584
2*b* (part), ...	24	45	204	4,896
Total, ...	194	...	...	52,705

3rd Period.

Sub-compartment.	Area, acres.	Average age of exploitation.	Yield of group per acre, cubic yards.	Total yield of group, cubic yards.
2*b* (remainder),	7	65	300	2,100
6*a*, ...	42	71	326	13,707
3*c* (remainder),	35	55	252	8,820
5*c*, ...	11	50	225	2,475
6*b*, ...	14	40	158	2,212
5*d*, ...	13	55	252	3,276
5*a*, ...	55	60	276	15,180
4*c*, ...	33	60	276	5,244
Total, ...	200	...	...	53,014

The average annual yield for the first period would, therefore, be 52,469 ÷ 20 = 2,624 cubic yards: for the second period, it would be 52,705 ÷ 20 = 2,636: and, for the third 53,014 ÷ 20 = 2,651.

The yield would, therefore, be fixed for the next 20 years at 2,600 cubic yards in round numbers. At the end of that period, or perhaps sooner, a fresh stock-taking and a revision of the whole scheme would be necessary, and the plan would have to be corrected in accordance with the new estimate. Frequent revisions are evidently necessary in the case of forests with long revolutions, for which the estimate of increment in young groups must always be very unreliable.

The guiding principle of Hartig's method appears to be that one generation should not be benefited at the expense of another: that each succeeding generation should have the full usufruct of the forest, but nothing more. The principle is undeniably sound in regard to public and entailed property, but it certainly cannot be carried out fully without neglecting other equally important considerations. Hartig made no attempt to bring about—no matter how gradually—a satisfactory arrangement of age-classes: in fact, unless the age-classes are normal at starting, it is difficult to see how a proper distribution can ever be attained by his method except by the merest chance. In the example just given, the forest area is of uniform quality, and each period, if normal, should consequently have an area of 180 acres, whereas the affectations vary from 150—200 acres, and will be more abnormal at the end than at the beginning of the revolution. Considering the great quantity of over-mature wood, this regularization of the yield, by holding over large areas of over-mature groups, could only be effected at considerable loss, and the principle of uniform annual yields is obviously carried too far. It is true that Hartig proposed to make good deficiencies, or surpluses, in any period, by increasing, or diminishing, thinnings according to requirements; but, as thinnings cannot be postponed or hurried on to any great extent without injury to the forest, and as they afford in any case comparatively small supplies, it is impossible to imagine that so large a surplus as that of the normal periodic area in the above example could be made good in subsequent periods by increased thinnings.

The impossibility of determining the prospective rate of growth of groups for long periods is a serious defect of Hartig's method, which depends for its accuracy entirely on the correctness of the estimate of increment for all groups to be cut during the revolution. The same uncertainty is experienced in estimating the amount of thinnings available during the revolution. The whole calculation of yield, in fact, rests on far too speculative data to admit of its being safely employed in seedling-forests, while for coppice the much more simple method of annual, or periodic, areas suffice for all practical purposes.

The loss, consequent on not cutting groups at the time of their exploitability, may be just as great by Hartig's method as by the methods of area—in the above example it is greater—but the latter have at least the merit of virtually bringing about the ideal state with the least possible delay, an object which cannot be attained by Hartig's method unless the age-classes are complete at starting. Its advantages as compared with area-methods are that the yield, if the estimate has been properly made, is uniform, and that it affords the fullest scope for natural regeneration by seed.

(*To be continued*).

PORTABLE FOREST TRAMWAYS; A DECAUVILLE'S TRAMWAY AT CHANGA MANGA.

In the interesting paper on forest tramways which appeared in the June Number of the "Forester," it is suggested that the employment of tramways in the forests of India might have the effect, by diminishing the cost of timber carriage, of increasing the money yield from these forests.

As this is a question of very great importance, an account of the working of a forest tramway at Changa Manga, and the general conclusions derived from a study of the results obtained by its employment, may be useful.

The Changa Manga plantation was commenced in *1866* by the late Dr. Stewart, Conservator of Forests in the Punjab, to meet the growing want for wood fuel, especially for railways. Only a very small area was, however, planted up to 1871, in which year a scheme for its organization and extension on a large scale was drawn up by Mr. Ribbentrop, and this led to an area of some 8,000 acres being successfully stocked in the course of the next few years.

The plantation is situated on a level plateau on the borders of the Bari Doab Canal, by which it is irrigated, and on the North-Western Railway line, 44 miles south from Lahore. Many species have been tried, but sissu has been chiefly cultivated, and the growth practically consists of that species only. Regular exploitations were commenced in 1881-82 in a crop 11 years old, and the forest is now worked by the method of coppice with standards on a rotation of 15 years, about 550 acres being felled annually, leaving 15 to 20 standards as reserves for timber per acre. Where the irrigation has been adequate and regular the growth of the sissu has been remarkably fast, showing 3 to 3·5 years per inch of average radius, and the annual production of wood compared with European forests enormous.

The compartments richest in material were felled first, and *yielded* when *11* years *old*, from the *fellings alone*, *2,624* cubic feet (stacked) of saleable fuel per acre. Including the material previously removed by thinnings, the annual production per acre of these compartments amounted to the high figure of 263 cubic feet (stacked)*, estimated to be equivalent to over 150 cubic feet, solid, of saleable fuel. These compartments had, however, been exceptionally well watered, and the *average* yield per acre from the fellings has now fallen considerably.

Only fuel has been produced up to the present. The railway administration purchases all or nearly all the produce of the fellings. For their purposes it is necessary to cut the wood into

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* These figures are taken from the control books kept up at the plantation.

billets $2\frac{1}{2}$ feet long; billets less than 6 inches in girth are not accepted, and billets over 2 feet 6 inches in girth have to be split so as to bring them within these dimensions. For these billets the Railway administration pays Rs. 5-8-0 per 100 cubic feet stacked, when delivered on the railway line and loaded into the trucks.

The *net* price received for this wood after deducting the cost of felling, cutting into billets, delivering and loading comes to about Rs. 4-8-0 per 100 cubic feet stacked, estimated to be equivalent to a net price of Rs. 6-13-0 per 100 cubic feet of solid wood. The smaller material, pieces under 2 inches in diameter, but not the brushwood, for which there is no sale, is sold locally, but only brings in a net income of about 4 annas per 100 cubic feet stacked.

The railway line on which the produce has to be delivered, skirts the plantation, its greatest distance from any part of the planted area being 4 miles in a straight line. A tramway line of a little over this length therefore dominates the whole area.

The conditions for employing a tramway line in Changa Manga are, therefore, exceptionally favorable. The forest is in a compact block at a short distance from the place of consumption of its produce, the ground, which is covered with a complete network of roads, is practically level, and the only obstructions, if we except the canal, which will eventually have to be bridged, are the irrigation channels, which can be temporarily bridged for a few annas. The production per acre is very high, the annual outturn of the exploitations, about 10,00,000 cubic feet stacked, including the smaller wood, is sufficiently large to render a considerable outlay of capital remunerative, and the products of the exploitations are delivered in a form peculiarly suitable for carriage by tramway.

In 1883-84 a firm of contractors purchased the standing crop on some 900 acres of the plantation, and imported, at cost of Rs. 7,648, (including freight from England,) a small portable Decauville's tramway of 16 inches gauge, to work out the produce. Much difficulty had always been experienced at Changa Manga in obtaining country carts in sufficient numbers to work out the wood in the time required. The neighbouring zamindars were willing to work during the slack season when not engaged with their crops; but this did not suit the requirements of the timber work, and higher rates had, consequently, to be paid in order to get carts when there was a press of work. On the completion of the contractor's work in May 1884, the tramway was, therefore, purchased by the Forest Department. The plant was subsequently increased by the purchase of 20 wagons and a mile and-a-half of rails. This tramway has now been in work for two years, and 11,22,000 cubic feet of stacked fuel have been extracted by it.

The plant purchased and its cost are as follows :—

Particulars.		Cost, Rs.	Remarks.
5,133 feet rails, ...		6,000	Purchased in May 1884 from Messrs. Robson and Co., Lahore. *The wagons, of which the original cost was about Rs. 90 each,* are now worth little, as they were not adapted for the carriage of wood and are broken. The rails are, however, still in excellent condition. The present value of this stock is estimated to be Rs. 4,400.
4 Crossings, ...			
20 Wagons, ...			
1 Box tools, ...			
Freight from Lahore to Changa Manga, ...		77	
2,500 feet of rails in sections, 5 mètres long, ...	RS. A. P. 2,500-0-0	3,118	Purchased in 1884-85 from *King & Co. Except the wagon* all are still in excellent condition. Estimated present value Rs. 2,800.
134 feet of rails straight sections, 2·50 mètres long,	154-12-0		
13 feet of curved sections, 2·50 mètres long, ...	184-4-0		
2 Crossings, ...	64-0-0		
2 Switches, ...	8-0-0		
1 Turntable, ...	55-0-0		
2 Off-railers, ...	32-0-0		
1 Wagon, ...	90-0-0		
1 Box tools, ...	30-0-0		
Agency fees, ...		75	
Carriage, Karachi to Changa *Manga,*		395	
	£ s. d.		
5,280 feet rails, ...	320-12-11	6,235	Purchased in 1885-86, from Messrs. King, King & Co. The present estimated value of this stock is Rs. 7,000.
2 Crossings, ...	4-8-0		
20 Wagons, ...	123-8-0		
1 Crowbar, ...	0-8-0		
2 Axles on wheels	1-10-0		
Packing, ...	15-13-0		
Total, ...	465 19 11		
Freight and insurance to Karachi, ...		515	
Carriage, Karachi to Changa Manga, ...		998	
30 bullocks, @ Rs. 12 each,		360	These cattle were already employed in the Division. They were not specially purchased for the tramway. Twelve have since died. The estimated present value of the remainder is Rs. 336.
10 do. @ „ 12 „		120	
Total Rs., ...		17,893	
Total capital outlay per mile of tramway line with rolling stock, ...		7,130	

The train is worked by bullocks. The rails are laid on the surface of the ground, which is only slightly smoothed to receive them; no sleepers are required. Each section of rails is complete; the parallel rails being joined by steel connecting rods.

The amount expended on working the tramway has been as follows:—

	Rs.
Loading and unloading the wagons, ...	981
Feed and keep of bullocks, ...	210
Carriage and laying of rails in the plantation,...	478
Repairs and other miscellaneous expenses, ...	295
Total expenditure on working, ...	1,964

The total quantity of fuel extracted has been—

1884-85, ...	6,18,000	cubic feet, stacked.
1885-86, ...	5,04,000	„ „
Total, ...	11,22,000	„ „

This fuel was carried various distances, varying from considerably under one mile to nearly two miles. Reducing* each load to a uniform distance of one mile, this quantity is found to be equivalent to 13,20,200 cubic feet carried one mile.

The outlay on work performed by machinery consists, it is hardly necessary to say, in the capital expended on the purchase of the machinery, the interest on this capital, and the pay of the labourers and other expenses of *working* the machinery. In considering the work done by the aid of a machine during a limited period, we must take, instead of the whole capital cost of the machine, a portion of this capital outlay, which we assume to represent the wear and tear or the capital used by the machine during the performance of the particular work considered.

In comparing the results obtained by employing different labour-saving machines, we must therefore take into consideration not alone the labour saved by one as compared with another, but also the capital outlay on the respective machines; and, *excluding considerations regarding the quality of the work* done, for one machine to be more profitable than another, the money value of the extra work done by it must be greater than the extra outlay necessary in order to employ it.

Assuming that—

$Q =$ Quantity of material to be transported.

$d =$ Distance in miles to which this material is to be transported.

* I am indebted to Mr. A. L. McIntire, Assistant Conservator of Forests, in charge of the plantation, for these figures showing the expenditure on working the tramway.

C = The cost of a tramway, including wagons, per mile.
c = The cost of the plant of the agency with which it is wished to compare the tramway.
N = The number of years the tramway plant will last in use under the conditions under consideration.
n = The number of years the plant of the other agency will last under similar conditions.
r = *The prevailing rate of interest on capital employed in* industrial undertakings of the sort.
P = Working expenses on extraction of a unit of material per unit of distance.
p = Ditto ditto for the other mode of transport.

The produce, Q, will cost to transport by tramway to a distance d—

$$PQd + \frac{dC}{N} + \frac{dCr}{100}, \qquad (1).$$

For PQd = Annual working expenses.

$\frac{dC}{N}$ = Wear and tear of plant.

$\frac{dCr}{100}$ = Interest on capital outlay.

Similarly the cost of extraction of the produce by the other mode of transport, which in this instance we will suppose to be bullock carts, would be—

$$pQd + \frac{c}{n} + \frac{cr}{100}, \qquad (2).$$

It is evident that d, the limit of distance to which it will be profitable to make a tramway, or the distance at which one mode of transport is as profitable as the other, can be determined from the equation—

$$PQd + \frac{dC}{N} + \frac{dCr}{100} = pQd + \frac{c}{n} + \frac{cr}{100}, \qquad (3).$$

If the tramway is f times as effective as the bullock carts or other agency with which it is being compared, then P in the above equation is evidently equal to $\frac{p}{f}$. Substituting this value for P in the equation we get—

$$pQd \left(1 - \frac{1}{f}\right) = \frac{dC}{N} + \frac{dCr}{100} - \frac{c}{n} - \frac{cr}{100}, \qquad (4).$$

But this expression $pQd\ (1 - \frac{1}{f})$ is the money value of the *labour* saved by employing the tramway. For the cost of transporting *the material Q to a distance D by cart is pQd.* By employing the tramway we can transport f times the quantity of material or fQ to the same distance at the same cost of pQd. Therefore the cost of transporting the material Q to this distance by tramway is $\frac{pQd}{f}$; therefore, the saving in cost of labour on transport by employing the tramway is $pQd - \frac{pQd}{f}$ or $pQd\ (1 - \frac{1}{f})$.

We can calculate the effectiveness of the tramway as compared with any other mode of transport from this equation—

$$\frac{1}{f} = \frac{pQd + \frac{c}{n} + \frac{cr}{100} - \frac{dC}{N} - \frac{dCr}{100}}{pQd}, \quad\ldots\ldots\ldots\ldots\ldots\ldots(5).$$

It may often happen that the machine or agency, bullock carts, for instance, with which we wish to compare the results of the tramway has hitherto been paid for by contract, so that we have no means of ascertaining the separate values of each of the quantities in the expression $pQd + \frac{c}{n} + \frac{cr}{100}$. But this contract rate, where the rate is a fair one, and not the result of a monopoly, is equivalent to the value of the whole expression and may be substituted for it.

If R be this rate, $QR = pQd + \frac{c}{n} + \frac{cr}{100}$, and the expression (2) becomes, *where R = rate for unit of distance,*

$$PQ + \frac{C}{N} + \frac{Cr}{100} = QR, \quad\ldots\ldots\ldots\ldots\ldots\ldots(6),$$

and equation (5) becomes

$$f = \frac{pQ}{QR - \frac{C}{N} - \frac{Cr}{100}}, \quad\ldots\ldots\ldots\ldots\ldots\ldots(7).$$

Some modifications are necessary in applying these equations to calculate the *average* annual cost of the extraction of the *annual* yield of forest by tramway. For in this case the distance to which the material is carried varies from year to year, while the length of rails, the chief item in the capital expenditure, remains the same.

In the preceding equations, d, the distance to which the material is transported, has been taken as the length of rails. But in calculating the annual charge on account of the tramway, we should take, to calculate the working expenses, the *average* distance the material would have to be transported during the *whole rotation*, while to calculate the capital outlay we must take the *greatest* distance or greatest length of rails required.*

If l = the maximum distance or length of rails,

d = the *average* distance to which the material has to be carried during the rotation,

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* Assuming the yield per acre to be *uniform*, and a_1, a_2, a_3, &c., to be the areas of the compartments; d_1, d_2, d_3, &c., to be the distances of these compartments from the place of consumption of the produce; A the area of the whole forest; the *average* distance to which the produce of the fellings would have to be carried during the whole rotation would be

$$= \frac{a_1 d_1 + a_2 d_2 + a_3 d_3, \text{ \&c., \&c.}}{A}$$

then the average annual cost on account of extracting the produce Q by tramway will be—

$$PQd + \frac{lC}{N} + \frac{lCr}{100}, \dots\dots\dots\dots\dots\dots (8).$$

To calculate the limit of distance to which it would be profitable to extend the tramway, we must substitute for d in equation (3) its value in terms of this limit, and of the *shortest* distance the material is carried during the rotation which is a constant.

If l be the limit of distance, and k the shortest distance, then $d = \frac{l+k}{2}$. Substituting this value for d in equation (3) we have

$$PQ\left(\frac{l+k}{2}\right) + \frac{lC}{N} + \frac{lCr}{100} = pQd + \frac{c}{n} + \frac{cr}{100}, \dots\dots\dots (9).$$

Or substituting the contract rate of hire

$$RQ, \text{ for } pQd + \frac{c}{n} + \frac{cr}{100}$$

$$l = \frac{RQ - \frac{pQk}{2}}{\frac{PQ}{2} + \frac{C}{N} + \frac{rC}{100}}, \dots\dots\dots\dots\dots\dots (10).$$

The value of l, the limit to which it will be profitable to extend the tramway, can be calculated from either of these expressions. Applying the above equations to the Changa Manga tramway, the annual yield of the forest being about 10,00,000 cubic feet stacked, therefore Q = 10,00,000.

The cost of the tramway plant per mile (neglecting the error involved by assuming that the capital outlay on *rolling* stock varies with the distance, which of course is not the case, but the error is small, is Rs. 7,130,

$$\text{or } C = 7{,}130.$$

The wear and tear of the plant may be taken to be, allowing for the time each portion has been in use, its original cost less its present value. This in round numbers amounts to 10 per cent. of the first cost, so that we may assume that the tramway will last 10 years, or that—

$$N = 10.$$

The prevailing rate of interest we may take (for Government undertakings) to be 4 per cent.

$$r = 4.$$

The working expenses on transporting by tramway 13,20,000 cubic feet of fuel to a distance of one mile were Rs. 1,964.

The cost (working expenses) in rupees of conveying 1 cubic foot this distance would be—

$$P = 0{\cdot}001488.$$

The *average* distance to which material has to be transported during the rotation is $1\frac{3}{4}$ miles—

$$\therefore d = 1{\cdot}75.$$

The *greatest* distance to which material has to be transported during a rotation, or the length of rails required is $4\frac{1}{2}$ miles—

$$\therefore l = 4{\cdot}5.$$

The least distance of the forest from the railway is zero ; consequently

$$k = 0.$$

From equation (8) it will be found that the average cost of extracting an *annual* yield of 10,00,000 cubic feet stacked of fuel during a whole rotation will come to—

$$0{\cdot}00148 \times 10,00,000 \times 1{\cdot}75 + \frac{4{\cdot}5 \times 7130}{10} + \frac{4{\cdot}5 \times 7130 \times 4}{100}$$

or $2,604 + 3,202{\cdot}5 + 1,283{\cdot}4 =$ Rs. 7,089·9. This comes to 11 annas 4 pie per 100 cubic feet stacked.

The rate charged by contractors for extracting fuel by country cart from the plantation has varied from Rs. 3 to Rs. 5 per 1,000 cubic feet, stacked, for the compartments near the railway line, and from Rs. 5 to Rs. 6 or 7 for the more distant compartment across the canal. As the higher rates would undoubtedly have to be paid in order to get carts in sufficient numbers to extract the produce in anything like the same time as can be done by tramway, we must, for purposes of comparison, make use of the *higher* rates. At an all round rate of Rs. 5 per 1,000, the *average* cost of extracting the annual yield of the plantation by country cart would come to Rs. 5,000 ; or 8 annas per 100 cubic feet (*stacked*).*

At this rate for country carts the limit of distance to which it will be profitable to carry the tramway will similarly be found from equation (10) (as $k = 0$) to be—

$$\frac{5 \times 1000}{\frac{0{\cdot}001488 \times 10,00,000}{2} + \frac{7130}{10} + \frac{4 \times 7130}{100}} = 2{\cdot}9 \text{ miles.}$$

In the above calculations the interest on capital outlay has been included, as this is necessary in order to compare the relative value of the machines. But in practice this interest would not appear in the recorded expenditure on account of the timber works. The income would be reduced periodically, every 10 years or so, by the amount expended on the purchase of the plant required, and for other years the expenditure would be only the actual cost of working the tramway.

Not including interest the *actual* cost of exploiting an annual yield of 10,00,000 cubic feet (stacked) of fuel from the Changa Manga plantation by tramway would amount, on an average for the whole rotation, to Rs. 5,806·5 instead of Rs. 5,000, which would have to be paid for its extraction by cart. As the work can be done with much greater certainty and in half the time by the tramway than it could be done by carts, the employment

* The weight of green sissu is about 65 to 70 lbs. per cubic foot; 100 cubic feet stacked of fuel pieces contain about 60 cubic feet *solid*, and weigh from 3,000 to 4,000 lbs. according to its state of dryness.

of the tramway has improved the position of the produce in the market, and, *indirectly* diminished the cost of the timber works by diminishing the cost of their supervision. The value of this supervision, the time saved to the *establishment*, is certainly worth more than Rs. 806 extra expenditure annually, which the employment of the tramway involves. The Changa Manga tramway may, therefore, be pronounced a financial success.

But it cannot be said that it has increased the money yield of the plantation. Nor would it appear possible that, in the majority of forests this could be the case in India; though as the figures here quoted refer to the transport of firewood only, it may be that saving of labour is much greater in the case of large timber.

But labour saving machinery, which is profitably employed in European countries, where labour is dear and capital abundant, cannot always be profitably introduced into countries like India, where labour is cheap and capital scarce. In India machinery is much more expensive than in Europe, and the interest on capital is higher. The extra cost involved in introducing new machinery is, therefore, much greater. On the other hand, as unskilled labour is cheap, the money value of the labour saved which has to meet and pay for the capital outlay on machinery is very much less than in Europe.

It must also be remembered that capital expended on machinery for the extraction of timber is heavily handicapped by the fact that, in very few forests can timber extraction be carried on during the whole or even the greater part of the year. During this period of rest the capital spent on machinery used in the transport of timber is unproductive. This capital outlay in the case of a tramway increases directly with the greatest length of rails required at *any time* during the rotation. With wheeled vehicles, or draught animals, the capital outlay does not increase to anything like the same extent; and the average expenditure for the whole rotation depends on the *average* distance to which the annual outturn of material is transported, and not on the greatest distance to which it may have been necessary to transport it at any one time.

Thus in Changa Manga, although the circumstances are exceptionally favourable, the annual charge on account of the capital outlay on the tramway is 64 per cent. of the total expenditure on account of the extraction of timber, and although the average distance to which the material has to be transported during a rotation is only one mile-and-three-quarters, four-and-a-half miles of rails have to be purchased.

From these facts we may infer that, in India, there are very few cases in which tramways or other expensive machinery for the transport of timber will be able to compete with the ordinary modes of conveyance of the country.

W. E. D'A.

NOTE ON THE ADVISABILITY OF APPLYING THE METHOD OF COPPICE WITH STANDARDS TO SOME FORESTS IN THE CEDED DISTRICTS.

THE Ceded Districts of the Madras Presidency comprise the Districts of Cuddapah, Kurnool, Bellary and Anantapur, and lying between the two Native States of Mysore and Hyderabad, form an isolated block, whose forests though differing a good deal in the arid taluks of Bellary from the moister Nallamalla hills in Kurnool, yet are of a sufficiently uniform character to allow of the same mode of treatment being applied to the greater portion of their area.

The area of forest in this region, hitherto notified as reserved forest, or now under settlement as such, is about 5,000 square miles. The chief characteristic of these forests is their poorness in valuable trees. An exhaustive list of the Forest Flora is published in the Madras Annual Report for 1884-85, but of the good timber trees therein enumerated, teak, blackwood, sandal and *Shorea Tumbuggia* are so rare as to be negligible quantities for the forester, and red sanders is confined to one corner of the Cuddapah district, where it grows gregariously, and forms a class of forest requiring special treatment, of which I will not speak further in this note.

The ordinary run of forest to which I wish to show the advisability of applying the method of coppice with standards varies in character from mere thorny scrub 10—20 feet high, presenting scarcely a single tree with any future before it, to fairly good deciduous forest 40—80 feet in height, which at first sight appears to contain a good proportion of trees reckoned valuable in the district, *viz.*, *Pterocarpus Marsupium*, *Terminalia tomentosa*, *T. Chebula*, *Hardwickia*, *Anogeissus latifolia*, *Bassia*, satinwood, ebony, &c.; but on closer examination it is found that almost without exception every tree over 4 feet girth is unsound, and that there is a lamentable absence of young poles, and that seedlings are entirely absent or are only those of the hardier soft-wooded trees.

I think it will be seen from what I have said above that the forests are very second rate compared with either the sal and deodar forests of Northern India, or the teak forests of the Western Ghauts, that they never will repay very intensive treatment, and that the amènagiste must try to settle them on some simple system under which all the operations can be performed by low paid native subordinates—Foresters and Forest Guards.

The two following observations that I made first led me to think that in treating forests in this dry region, where the rainfall is scanty and the ground always hard, we should seek their regeneration more by coppice shoots with seedlings as auxiliaries than by seed alone:—

"(1). In the Cuddapah district about 10 years ago certain portions of forest, mostly scrub, were reserved and enclosed with expensive fences and carefully protected against cattle and fire. What has been the result? The trees have grown it is true, but at what rate? It has been variously estimated at $\frac{1}{10}$ to $\frac{1}{4}$ ton per acre per annum. The trees are low-branched and flat-topped, and seedlings are almost entirely absent, on account I think of the low cover and hard soil.

"(2). Again, I found that on boundary lines cut in the same class of forest, coppice shoots come up with the greatest vigour, and are not totally destroyed as seedlings would be, even when fire passes through them in their first year."

The conclusion that I came to was that if these reserves had been cut clean over as soon as they were fenced in and fire-protection assured, we should have at the present date a fine young coppice growth, which could either be maintained as such, or gradually converted into high forest, instead of a miserable scrub incapable of reproducing itself by seed and growing every year *less apt to reproduce itself by coppice shoots.*

Having treated of cultural reasons, I will now pass to others not less important, *viz.*, the demands of the timber trade and facilities for exploitation and control. With regard to the former, the most important consumers of forest produce are without doubt railways, of which the Ceded Districts contain a very considerable mileage. The Madras Railway runs through from north to south, the Bellary-Kistna and Southern Mahratta system crosses from east to west, and there are other famine lines surveyed and sanctioned which will shortly be constructed. But these railways are laid with iron sleepers, and for the construction of their buildings and rolling stock they prefer Burma teak, which is at present obtainable in Madras at a very low price, to the inferior local woods. Thus the only local product they consume is firewood, and there is not the slightest chance of coal being substituted for wood so long as wood is available at present prices. The local demand is for firewood for domestic purposes, boiling sugarcane and smelting iron, (though this latter industry is dying out,) for timber of small scantling (9″ × 6″ × 16′ being about the largest size in demand), and for poles and bamboos. *For poles of good sorts the demand is very great.*

I submit that the system of coppice with standards is eminently suited for supplying these demands. The revolution should be long 25—30 years, which would produce poles 6—12 inches in diameter; those of the better sorts would be used for building purposes, construction of carts, &c., &c., and the rest for firewood. The reserves of two and three revolutions would yield the kind of timber in demand in the neighbourhood.

Of course this system could not be applied to the whole area, as in the more remote portions of the forest timber alone is marketable, but still there are about 500—600 square miles, say

10 per cent. of the whole forest area which are sufficiently near to railways and small towns to insure the sale of the firewood.

The advantages of this system over all others in the way of police, control, and method of executing the fellings will be best shown in taking them one by one and demonstrating the difficulties that lie in the way of their application.

The system of "thinnings" or natural "reproduction" requires not only skilled supervision, but also very intelligent men to mark the trees that are to be felled in every operation which the revenue derived from these forests would never justify us in employing; to say nothing of the expensive survey on a large scale which would be a necessary preliminary. Besides this, I do not think that the poorer scrub is capable of reproducing itself by seed, and it would in any case be necessary for it to first pass through two or three rotations of coppice so as to get a sufficient number of standards of the good sorts capable of bearing seed.

It would be equally difficult to apply the primitive method, as the chief products required are firewood and poles, and the size of the trees is so irregular, that the possibility would have to be fixed by volume, which is always dangerous, and here with our very limited knowledge of the annual production might lead to very disastrous results.

The "cut and come again," or license and voucher system, which was in vogue in these forests when the object of Government was simply to obtain revenue, may be condemned without further argument. A modified form of it, in which five or six of the principal trees are reserved from felling, might be retained in the more remote parts, which will, howvoer, be chiefly worked for grazing, which these forests will have to provide for to a very large extent.

In working under the system of coppice with standards, the following advantages may be enumerated :—

(1). An elaborate survey will not be necessary either of the ground or of the crops.

(2). The system gives very good results under very rough treatment. The marking of standards can be done by Forest Guards subject to subsequent inspection by Forester or Ranger. On this point it stands far above any other system.

(3). The controlling officer, after a compartment has been cut, can see at a glance if the work has been properly done, and that no fraud has been committed by the contractor, which is very difficult to do when selection fellings and thinnings are going on over a large area.

(4). This system more than any other enables the Forester to increase the proportion of superior species at the expense of the inferior ones, a result which is often reversed under other systems, where the tendency is always for the strongest to take possession of the soil.

(5). Lastly, but by no means least, it is possible to substitute sales of standing crop for departmental working, without which it is difficult to manage forests on any other system, and regarding which I think experience has shown that in India it does not pay in forests where inferior timber, poles and firewood form the only products.

KONDA DORA.

NUTRITION OF CUPULIFERÆ.*

WE wish to give some account to our readers of a recent discovery, which bids fair to exercise a complete revolution in the field of vegetable physiology. The subject is of primary interest to the Foresters, as it concerns one most important forest species, presenting as it does the question of the nutrition of the oak, beech and hornbeam from an entirely unsuspected point of view. *A new light has been thrown on this question,* the difficulty of which naturalists have had good reason to believe were smoothed away since Sach's famous experiments.

For this discovery we are again indebted to Germany, a country which may be styled the laboratory of natural science, and which, thanks to the untiring investigations of the scientists of the Wurzburg Institute, particularly has so largely contributed to the advancement of our knowledge of vegetable physiology.

Dr. Frank, a learned professor of the Berlin University, is of opinion as the result of numerous experiments, that various *ligneous species are nourished by the intermediary* of underground fungi. This appears an odd theory: hitherto we have been taught that all trees obtain such constituent elements of these compositions as are procured from the soil, by means of their slender fibrils. This is not so however: all trees do not act thus. Oaks especially do not directly obtain the smallest nutritive particle from the soil; but there exists around their roots a complete envelope formed by a fungus, to which the functions of nutrition are exclusively confided. This envelope is intimately connected with the root, growing with it acts as a morphological organ, *Dr. Frank has called mycorhiza.*

This mycorhiza is in the form of a pseudo-parenchyma composed of several layers of cells irregularly interlaced and forming a dense reticulation. Not only does it cover very completely the epidermis of the root, but it penetrates into the interior of the epidermal cells. The formation of root-hairs is totally prevented, and what might be taken to be the latter are filiform ramifications of the fungus arising from prolongations of its internal cells.

The growth of the envelope follows that of the root in a par-

* Translated from the "Revue des Eaux et Forêts" for March 1886.

allel manner; one line indicates the termination of one and the other, so that the fungus remains in close proximity to the growing point. Nevertheless the physiological organic union occurs very little behind this point, and only at that spot where the longitudinal growth of the free cells is terminated.

When a young germinating plant is examined, the presence of this fungus is not at first apparent. It is first seen on the young lateral roots, grows slowly on these, persists for a short period only, and in any case is destroyed when these organs attain maturity.

The *mycorhiza* gives rise to a striking alteration in the root growth. While roots free from this parasite remain thin and elongated, producing far-spreading lateral ramifications, the mycorhiza grows very slowly and engenders short and thick roots, from which exactly similar ramifications arise, the whole resembling a growth of coral.

Dr. Frank's observations give as result—that the Cupuliferæ and Corylaceæ (oak, beech, chestnut, hornbeam, hazel) are always attacked by this parasite; that the Salicineæ (willows and poplars) are frequently so; and that finally the birch, alder, plane, walnut, robinia, lime, maple, ash, elder and generally all shrubs, are never so attacked.

The author of this theory has endeavoured to determine in what category this fungus should be included: it appears that it would probably be among the tuberaceæ or the gasteromycetes. Until a careful examination has been made of this fungus growth while fructifying, it will be impossible to give a definite answer to this question. The mycorhiza of a truffle-bed has been examined, and absolutely no difference found between it and the mycorhiza described above. Dr. Frank believes, therefore, that he is justified in asserting, that it is really this fungus which produces the truffle, and that, if the latter be the rarer of the two, it is because its fructification is usually prevented by various external conditions.

Finally, the author of this theory expresses himself as follows relatively to the physiological importance of the mycorhiza:—

"The mycelium of this fungus must be regarded as a parasite upon the root of the trees, from which it borrows the carbonised materials assimilated by the leaves. On the other hand it furnishes the tree with all its mineral elements, together with the water which it requires: alone it fulfils this *rôle*, because alone it is in contact with the soil. Thus these two vegetable organizations exist side by side and without any mutual injury, assist each other."

We have sketched in a summary manner the new theory which Dr. Frank has imagined. This doctrine is entirely in accordance with the scientific ideas of the day. Have not, in fact, chemistry and medicine during the last few years, generalised the important *rôle* played by fungi in natural phenomena?

And now the science of sylviculture is, in its infancy, becoming complicated by the study of these inferior organisms.

Dr. Frank is not a forester; but who knows that he will not cause an immense progress in sylviculture; who can foretell the practical consequences which his discovery may lead to. It rests with us foresters to deduce them: a new field of study is open to us; let us enthusiastically apply ourselves to the task!

ROUGH NOTES ON THE TUSSUR SILK-WORM IN ITS DIFFERENT STAGES.

THE first collection of cocoons was made by me in October on my coming out to the forests. They were gathered from different kinds of trees, for instance, the sal, asyna, jáman, chilla, carya, &c.

I put them away carefully in a box, examining them daily. They remained in a dormant state till towards the end of March, when the first change was noticed. The development from the chrysalis state to the moth takes place inside the cocoon.

This can be seen by carefully cutting the cocoon in two, taking care not to injure the chrysalis. The thick skin of the chrysalis gradually becomes soft at the time of change, and the exit is made from the upper or head portion. The moth moistens the end of the cocoon, which, being softened, enables it to work its way out, leaving the shell inside the cocoon.

It is then in a very cramped state, but in about 15 minutes the wings spread out, measuring from 6 to 8 inches, though it cannot fly for three or four hours.

The female can be distinguished from the male by its feelers, which are like tiny ferns, very thin and narrow, those of the male being broad and thick. The female is about a third longer than the male.

As is the case with all moths, their flights are only made at night. In the evening, or about dusk, I put out several females, tying them, by their right wings, with pieces of thread some 18 inches long, to trees and bushes out in the open, on the skirts of the forest. The use of the long thread was to enable the moth to flutter about. The moth flight commences from about midnight, and they fly about till about 3 A.M., when the male, attracted by the flutter of the female, consummate their brief marriage, remaining in position till sunrise, when he leaves her, and returns to the shade of the dense jungle.

The female moth commences to lay immediately, and will lay from 150 to 200 eggs, both male and female dying in about 15 days. If the eggs are not fertilized, they flatten out and dry up very shortly, but if all right, hatch in about a fortnight.

When first hatched, the caterpillars are of a yellowish brown colour, and the yellow colour deepens as they approach their first change, about the 9th day; they then spin a little silk on to a branch or leaf on which they thus obtain a firm hold. They then burst their skins and crawl out, leaving the old skin behind.

The *second change* commences about the 20th day, the third about the 30th, and the fourth and last change about the 40th day, each change taking about three days to complete.

During the changing periods they eat nothing, but during the rest of the time feed ravenously on green leaves, and a caterpillar after his last change will every day consume a fully developed sal leaf. In about 15 days after the last change, the caterpillars commence spinning their cocoons, getting into the chrysalis state in some six or eight days.

Some caterpillars I reared were hatched on the 28th March. They *commenced* their first change on the 6th April and finished on 8th; the second change commenced 17th April, finished 19th; the third change commenced 26th April, finished 28th April; the fourth and last change commenced 7th May, finished 9th May; and they spun their cocoons on the 19th May. Four crops of cocoons can be gathered in the year, *viz.*, in April, June, August and October.

I am sending you a box of moths, and you will see that they are differently coloured. At first I attributed this to the caterpillars feeding on the leaves of different trees; for instance, the *reddish coloured ones* on asyna, the yellow on jáman, &c., but I find I was mistaken, as the batch of caterpillars I just reared were all fed on sal, but the moths were of different colours.

The cause I cannot explain. I am also sending you, preserved in spirits of wine, specimens of the caterpillars in their different stages. I have already stated that the caterpillars feed ravenously on the leaves of certain trees, but whether that does any damage to the trees themselves I cannot say. I have also noticed that after the caterpillar has changed skin, he turns round and eats a portion of the old skin. I noticed it on *several occasions* with the batch I just reared.

DUDWA GHAT,
27th June, 1886.

C. W. ALLAN.

IV. Notes, Queries and Extracts.

WOOD FOR CIGAR BOXES, &c.

With regard to the query above, and the reply of EX-STUDENT in June number, I should say there can be little doubt that one of the best woods, or even the very best of all, is Poma (*Cedrela Toona*). It has all the qualities needed, *i.e.*, color, lightness, durability and ease in working. There are many good woods, but their color, or rather want of color, is against them.

The Poma or cedar-like tún has all the qualities required in a very high degree. It is a real wonder that this most useful of all our trees in India is not *extensively* planted, *i.e.*, that large areas are not devoted to it alone in all provinces. It grows remarkably easily, and seeds profusely; the seeds germinate at once, and it also bears transplanting.

I cannot bear out EX-STUDENT's recommendation of Sum, (*Machilus odoratissima*). I have worked a great deal of it, *i.e.*, about 800,000 superficial feet, during the last three years. It is heavy and rather cross-grained, besides being the tree on which silk-worms are reared. The wood of woods for cigar boxes is undoubtedly Poma, or the cedar-like tún.*

SIBSAGAR, ASSAM, *11th July, 1886.* S. E. PEAL.

It will be remembered that on pages 155-58, Vol. IX. of the "Indian Forester," Dr. Warth, in publishing a summary of the meteorological observations taken at the Forest School, drew our attention to the very interesting fact that as long as the minima temperatures observed respectively at the low and high level stations were appreciably different, fair weather was prognosticated, and that when these two temperatures approached one another, rain was indicated. The explanation of this phenomenon will be found in the following translated extract from our Spanish contemporary, the "Revista de Montes":—

* Mr. Sutherland, the Manager of the Indo-Havana Company of Meerut, was supplied with tún wood from Dehra Dun, and writes to say that it has given very satisfactory results for cigar boxes, which are of equally good appearance, though slightly costlier than Spanish cedar, the wood used for boxing all high class cigars.—[ED.]

"Continuing his observations regarding all that relates to the phenomena of heat, Dr. Tyndall compared the readings at the same hour of the night of two differently placed thermometers. One thermometer was suspended in the air at 4 feet above the ground, while the other rested on a cotton pad placed on soil cleared of all vegetation. The experiment was carried on away from buildings, and from whatever was likely to interfere, however so little, with free radiation.

"Under these conditions the thermometer on the ground indicated a lower temperature than the other, and the difference between the two readings varied from 4° to 18° Fah. While the moist south-west wind was blowing, or immediately after heavy rain had fallen, the difference was always slight, and even under an absolutely clear sky, which ought to have favoured radiation, the difference did not exceed 6° or 7°.

"On the other hand if the observations were taken during the prevalence of dry winds from the north and north-east, the difference was much more considerable, a circumstance that proved a much more active radiation than before.

"The conclusion to be drawn from these observations is apparently that the watery vapour suspended in the atmosphere, without interfering with its diaphaneity, acts as a sort of medium which impedes the passage of heat and retards the cooling of the ground by radiation."

NEW TANNING MATERIALS.—We have been favoured with a new extract—that of "sal" bark—forwarded to us by the Conservator of Forests in Oudh, India. There are large forests mainly composed of these trees in certain districts in India, so that the supply may be said to be inexhaustible. Its value as a tanning agent has, however, to be tested in the tannery.

Copy of Analysis. Extract of "Sal" Bark.

Specific Gravity 1·333 = 36 degrees Baume.

Moisture, ...	32·41	per cent.
Reduced to ashes, ...	63·56	„
Tannic Acid, ...	32·29	„
Non-Tannin, ...	3·93	„

The colour of the solution is a brownish red, and from its reactions we should not judge it to be a weight-giving material.—*Leather.*

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FOREST ORGANIZATION FOR BEGINNERS.

(*Continued from page 348*).

CHAPTER VI.

DETERMINATION OF THE YIELD OF FORESTS REGENERATED BY THE METHOD OF REGULAR CUTTINGS—(*concluded*).

4.—THE COMBINED METHOD.

WHILE the methods of area demand that almost exclusive attention be paid to a regularization of the age-classes, and Hartig would sacrifice all other considerations for the sake of uniform annual yields during the revolution, the main object of that form of the combined method, which is now generally adopted, is to steer a middle-course between these two extremes: to pay proper attention to the ultimate attainment of a satisfactory state of age-classes and sequences, without unduly favouring future, at the cost of present, generations.

When, two or three centuries ago, the forests of Europe were thought to be disappearing, and some sort of system in exploitation came to be regarded as essential to save them from devastation, all that at that time was deemed necessary in the matter of organization was the establishment of a sustained yield with the least possible delay. The shortest road to this end was considered to be the division of the forest into a number of coupes equal to the number of years in the revolution, and the cutting over of one each year. But in seedling-forests, as already explained, simple methods of area, besides presenting other drawbacks, do not necessarily lead to a sustained yield. Later on the method of proportional coupes was introduced, and, towards the end of last century, Hartig's method, either of which, provided the data on which the estimate rests be correct, and that nothing unforeseen arises to disturb the plan, certainly would afford what practically amounts to equal annual yields by the end of one

revolution. In the mean time, however, forests had been steadily increasing in value, and, since the beginning of this century, the idea has gradually gained ground that a sustained yield, however much to be desired, may be too dearly bought, and that, even from a politico-economical point of view, it may be more advantageous to exploit groups at the most useful period of their existence than to attain uniform periodic yields, or an ideal state of age-classes, by sacrificing young groups, or by holding over mature groups long after their proper term. The futility of attempting to determine the increment for long terms, as well as the exact time of exploitation of every group to the remotest period, no doubt contributed considerably towards this more rational view of the matter. At the present day, therefore, the most eminent authorities have completely abandoned the notion that a regularization of age-classes, or a sustained yield, is the only object to be considered in organizing a forest, and hold that, for all practical purposes, it should suffice to determine the yield of the first period only, which should be fixed after duly weighing all considerations of sylviculture and economy.

There are many varieties of the combined method, but all have this characteristic, that the periodic yield is fixed by area, while the annual yield during a period is determined from an estimate of the average annual yield of the standing-stock appertaining to such period. One form demands equal affectations: in another, the chief object is to attain equal periodic yields, at the cost of more or less unequal periodic areas: a third insists on the continuity of each periodic area, while a fourth affords full scope for the selection of groups of an affectation from the whole series. Some, again, require an estimate of yield for the whole revolution; others, only that of the first 10—20 years.

The combined method having been evolved from the two methods last described, the oldest form is naturally that which requires the estimate of yield for the whole revolution. Owing, however, in a great measure, to the difficulty of determining prospective yield for a long term of years, the calculation in recent times has, as already observed, been generally confined to an estimate of the yield of the first period.* There is certainly no harm in attempting to estimate the yields of all affectations, but experience teaches that such estimates are sure to be upset, and that it is quite impossible to place any reliance on forecasts for more than a comparatively short space of time. When, therefore, an estimate is made for the whole revolution, the estimated yields and proposed distribution of groups of later

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* Perhaps this statement is too sweeping. It appears that the older system is still very general in France. In Germany, it has long been abandoned for the reason given in the text, and because an equalization of the yields of periods, which is the sole *raison d'être* of the method, is no longer considered essential to a good scheme of exploitation.

periods can only serve to give a rough idea of the probable returns and course of events.

For the purpose of illustrating this method, we will take the forest described at page 339, (August Number.)

The area of the series being 540 acres and the revolution 60 years, the normal coupe would be $540 \div 60 = 9$ acres ; and each normal periodic area (the forest being of uniform fertility throughout) would be $9 \times 20 = 180$ acres, for periods of 20 years.

The following table shows the normal and actual states of the age-classes which proceed by differences of 20 years :—

Age-class.	Area occupied by each age-class.			
	Normal.	Actual.	Too much.	Too little
1—20, I, ...	180	192	12	...
21—40, II, ...	180	159	...	21
41—60, III, ...	180	189	9	...

A blank of 13 acres is included in the first class. There is a large stock of over-mature wood : 54 acres of groups 80 years old, and 71 acres of groups 65 years old, together 125 acres. The remaining groups, which would naturally be cut during the first period, with the exception of 4*b* of 14 acres, stocked with a group 55 years old, would all have to be exploited at an average age of 55 if the normal periodic area is worked out during the first period. The quality of the groups is uniform, and they are of uniform density throughout, so that the proportion of inferior and superior groups in the several age-classes has not to be considered in this case. The old groups in 1*a*, 2*c* and 6*b* are long past their proper term, and it is desirable that they should be replaced by young growth with the least possible delay. This is all the more necessary, as it is to be feared that they will soon become unsuitable for natural reproduction by seed, which is the mode of regeneration that it is desired to apply to them. On the other hand, there is a rather serious deficiency in the second age-class, which would, in itself, render the husbanding of the resources of the first desirable. The produce is chiefly exported, and there is no fear of injuriously affecting prices by cutting considerably more than the normal yield during the first period. All things considered, the organizer thinks it advisable to put about the normal area into the first affectation, but to split it up into two portions for the purpose of calculating the yield, so as to enable the manager to hasten the cutting of very old groups, and to retard cut-

tings during the latter part of the period. In pursuance of this plan, it is proposed to cut annually for the first ten years 3,200 cubic yards, in round numbers; but, during the second half of the period, only 2,850 cubic yards. This estimate is arrived at as follows :—

1st Decade.

Compartment.	Area, acres.	Present age of group.	Average age of exploitation.	Yield per acre, cubic yards.	Yield of group, cubic yards.
1*a*, ...	30	80	85	385	11,550
2*c*, ...	10	80	85	385	3,850
6*b*, ...	14	80	85	385	5,390
2*d*, ...	15	65	70	321	4,815
3*a* (part), ...	21	65	70	321	6,741
Total, ...	90	...	...	...	32,346
				Mean yearly yield, ...	3,235

2nd Decade.

Compartment.	Area, acres.	Present age of group.	Average age of exploitation.	Yield per acre, cubic yards.	Yield of group, cubic yards.
3*a* (remainder),	35	65	80	364	12,740
4*a*, ...	43	45	60	276	11,868
4*b*, ...	12	55	70	321	3,852
Total, ...	90	...	...	...	28,460
				Mean yearly yield, ...	2,846

The above arrangement gives 180 acres for the whole period, which is the normal area of the affectation. That the groups chosen for cutting are suitable has been shown in the previous example, (*see* page 339, August Number.)

To enter upon further calculations with a view to fixing the yield of the next period, or next two periods, would be quite superfluous. A glance at the age-classes at once shows that ample provision has been made for the future, and that it will be quite soon enough if the calculation be continued at the end of the first period, when the organizer will be in a much better position to estimate the yield of the second period. If, however,

it is desired to obtain a rough idea of the probable plan of exploitation during the next two periods, the following provisional allotment of groups might be made, when, if the increment remained the same, the yields shown below would result. It is unnecessary to say, after what has been already said, that the calculation of the yield of the second and third period is unnecessary.

2nd Period.

Compartment.	Area, acres.	Present age of group.	Average age of exploitation.	Yield per acre, c. yards.	Total yield of group, c. yards.	Remarks.
4*b* (remainder),	2	75	85	385	770	
3*c* (part), ...	2	25	35	120	240	3*c*, safety cutting.
3*d*, ...	7	65	75	343	2,401	
1*c*, ...	12	35	45	204	2,448	
2*a*, ...	45	50	60	276	12,420	
5*b*, ...	30	50	60	276	8,280	
4*d*, ...	14	50	60	276	3,864	
3*b*, ...	8	50	60	276	2,208	
1*b*, ...	20	41	51	229	4,580	
2*b*, ...	31	35	45	204	6,324	
6*a* (part), ...	9	41	51	229	2,061	
Total, ...	180	...	...	...	45,596	
		Mean yearly yield, ...			2,280	

3rd Period.

Compartment.	Area, acres.	Present age of group.	Average age of exploitation.	Yield per acre, c. yards	Total yield of group, c. yards.	Remarks.
6*a* (remainder),	33	61	71	326	10,758	6*b*, second time of cutting during revolution.
3*c* (remainder),	35	45	55	276	8,820	
5*c*, ...	11	40	50	225	2,475	
6*b*, ...	14	30	40	158	2,212	
5*d*, ...	13	45	55	252	3,276	
5*a*, ...	55	50	60	276	15,180	
4*c* (part), ...	19	50	60	276	5,244	
Total, ...	180	...	...	...	47,965	
		Mean yearly yield, ...			2,398	

The station being of uniform quality throughout, the annual yield of the ideal state would be $9 \times 276 = 2{,}484$ cubic yards, (9 acres being the normal annual coupe, and 276 cubic yards the yield per acre of a group 60 years old,) and, if things turned out as anticipated, the actual yield would be fairly normal during the third period, and not very far off normality during the second.

The estimate of yield for the first period does not include yields from thinnings and minor produce. The average annual yield, if any, from these sources would have to be added in order to give the full return.

The yield from thinnings may be taken as equal to the average annual yield of the last five years, or it may be estimated after a careful examination of the groups to be thinned during the period, or at so and so much per cent. of the main yield, or from experiential tables. Minor produce (stones, fruit, sap, earth, honey, &c.) may be estimated on the average return of the last five years.

The advantages of the combined method are, as regards seedling-forest, that the affectations being fixed by area, excessive or insufficient cuttings are easily guarded against, and that certain provision can be made for future periods; at the same time, uniform annual yields are obtained during each period, and the manager is afforded ample scope for the exercise of judgment in the selection of groups for regeneration. Due attention can also be paid to the economical side of the question, which is not possible by those methods, previously described, which are based on a fixed idea to which all other considerations must give way.

CHAPTER VII.

Determination of the Yield of Overwood and of Series subject to the Method of Selection.

1.—Overwood-series.

Here two distinct modes of treatment are necessary, one for the overwood, the other for the underwood.

The underwood may be most conveniently treated by the method of equal areas, or of areas inversely proportional to their supposed productive power. The former will generally be found sufficient for all practical purposes.

The overwood may be regarded as open seedling-forest without reference to the underwood. It is convenient, and usual, to choose a revolution for the overwood which is a multiple of that of the underwood, so that if r represents the revolution of the underwood, mr may represent that of the overwood; in that case, if the revolution of the coppice were 30 years, and that of the standards 90, m would be equal to 3.

For the underwood in an ideal forest, the area of the annual coupe is equal to $\frac{A}{r}$, when A represents the area of the forest. The area occupied by one age-class of the coppice is equal to $n\frac{A}{r}$, when n represents the number of years in each such class; but the area occupied by each age-class of the overwood can not be determined in a practical way, because a confused mass of trees of various ages occur on each coupe of the underwood. In the ideal forest, however, we may, for the sake of clearness, picture to ourselves each class separated from the mass and occupying a compact area by itself, in which case there would be mr groups of standards in a regular series from 1 to mr years old, each occupying a space equal to $\frac{A}{mr}$. For, the oldest coupe of the underwood would contain standards of the following ages:—

$$r, \quad 2r, \quad 3r, \quad \ldots \quad mr$$

The next in age of $r - 1, \quad 2r - 1, \quad 3r - 1, \quad \ldots \quad mr - 1$

The third oldest of $r - 2, \quad 2r - 2, \quad 3r - 2, \quad \ldots \quad mr - 2$

And so on, down to the last coupe of the underwood, with group $r - r = 0$ years old, which will contain standards—

$$r - r, \; 2r - r, \; 3r - r, \quad \ldots\ldots \quad mr - r, \text{ years old.}$$

that is to say

$$0, \; r, \; 2r, \quad \ldots\ldots\ldots \quad (m - 1)\, r, \text{ years old.}$$

There would, therefore, be a complete series of standards of all ages from 1 to mr years old. If, now, we assume that each class occupies an equal area, as in the ideal forest it would do, and if the standards are regarded in the light of open forest occupying the whole of the area, one year's coupe will be $\frac{A}{mr}$ in size, and the area occupied by each age-class will be $n\frac{A}{mr}$.

For a forest 100 acres in extent, with a revolution for its coppice of ten years, and one of 40 for its standards, the yearly underwood coupe would be $\frac{100}{10} = 10$ acres.

The overwood-coupe would be $\frac{100}{40} = 2\frac{1}{2}$ acres.

If the age-classes are taken for periods of five years each, there would be—

Class	I. Underwood (trees 1 to 5 years old)	$\frac{5 \times 100}{10} = 50$	acres.
„	I. Overwood (1 to 5 years old)	$\frac{5 \times 100}{40} = 12\frac{1}{2}$	„
„	II. Underwood (trees 6 to 10 years)	$10 \times 5 = 50$	„
„	II. Overwood „ „	$2\frac{1}{2} \times 5 = 12\frac{1}{2}$	„

And so on, for remaining overwood-classes.

Four classes of the overwood occupy the same area as one of the underwood, so that by taking the area of the latter as the area of one age-class, there would be

I. Class.

Underwood—50 acres	with trees	1-5	years old.
Overwood—	,,	,,	1-20	,,

II. Class.

Underwood—50 acres	with trees	6-10	years old.
Overwood—	,,	,,	21-40	,,

The number of gradations of age in the overwood is generally taken as $\frac{mr}{r} - 1$, when mr is the revolution of the standards, r that of the coppice. The first class is then supposed to belong to the coppice, being of the same age as, and undistinguishable from, it.

For practical purposes what has to be decided is the number of trees, or their cubic contents, of each age-class of a series, to be permanently maintained. This cannot be ascertained accurately, but it is possible to obtain a more or less correct estimate which may serve as a guide. The first thing to determine is the area of the ideal annual coupe. This, as we have seen, is equal to $\frac{A}{mr}$. The degree of cover admissible has then to be decided. This depends on the species constituting the underwood and on those forming the overwood—whether the former are shade-enduring or light-demanding, and the latter densely-leaved or open-crowned—on the station, and the comparative demand for coppice and standards. The degree of cover chosen is expressed in decimals, full cover being equal to unity. The cover may be determined by measuring the area occupied by a number of trees of the mean age required, and striking an average. The area occupied by a tree is found by measuring the area enclosed by (imaginary) perpendicular lines dropped from the tips of the outermost branches. If s_1, s_2, s_3, &c., represent the surfaces taken up by test-trees of the 1st, 2nd, and 3rd classes, respectively, q the degree of cover decided on for the overwood, and $n\frac{A}{mr}$ the area of an age-class, the number of trees in each class will evidently be :—

$$\text{Class I. } \frac{n\frac{A}{mr}}{s_1} \times q.; \text{ Class II. } \frac{n\frac{A}{mr}}{s_2} \times q.; \text{ Class III. } \frac{n\frac{A}{n \cdot r}}{s_3} \times q,$$

and so on.

Supposing we have an ideal forest of overwood, 120 acres in extent, with a revolution of 60 years ; $q = \cdot 25$: age-classes proceeding by differences of 10 years : and that the following average values have been obtained of s_1, s_2, &c. :—

$s_1 = 3$ square yards ; $s_2 = 6$ square yards ; $s_3 = 10$ square yards.
$s_4 = 16$ square yards ; $s_5 = 25$ square yards ; $s_6 = 36$ square yards.

The yearly cutting will be $\frac{120}{30} = 2$ acres $= 9{,}680$ square yards.

Each class will occupy 20 acres. The number of trees in each class will be as follows :—

$$\text{Class I. (1 to 10 years old)} = 10 \times \frac{9680}{3} \times \cdot 25 = 8{,}067$$

$$\text{Class II. (11 to 20 years)} = 10 \times \frac{9680}{6} \times \cdot 25 = 4{,}034$$

$$\text{Class III. (21 to 30 years)} = 10 \times \frac{9680}{10} \times \cdot 25 = 2{,}420$$

$$\text{Class IV. (31 to 40 years)} = 10 \times \frac{9680}{16} \times \cdot 25 = 1{,}513$$

$$\text{Class V. (41 to 50 years)} = 10 \times \frac{9680}{25} \times \cdot 25 = 968$$

$$\text{Class VI. (51 to 60 years)} = 10 \times \frac{9680}{36} \times \cdot 25 = 672$$

This represents the ideal quantity of standing-stock immediately before a cutting. On each coupe of the underwood there will be trees representing each age-class of the overwood, each class occupying an equal area. If, in the above example, *the revolution* of the underwood were ten years, its annual coupe would be $\frac{120}{10} = 12$ acres, and on the oldest, just before a cutting, there would be overwood 60, 50, 40, 30, 20, 10 years old. The next in order would have overwood 59, 49, 39, 29, 19, 9 years old, and so on in regular succession down to the youngest with overwood 50, 40, 30, 20, 10, 1 years old. Each underwood-coupe would have 807 first-class standards, 403 of the second, 242 of the third, 151 of the fourth, 97 of the fifth, and 67 of the sixth class. On the oldest coupe, for example, there would be 807 standards ten years old, 403 twenty, 242 thirty, 151 forty, 97 fifty, and 67 sixty years old ; the annual yield being 404 of the first class (virtually belonging to the coppice), 161 of the second, 91 of the third, 54 of the fourth, 30 of the fifth, and 67 of the sixth class.

The contents of the average tree for each class being known, it is, of course, easy to estimate the contents of the standing-stock of a normal series.

If, for instance, the test-trees in the above example contained on an average 0·02 cubic feet for Class I., 2·0 cubic feet for Class II., 7·2 cubic feet for Class III., 18·0 cubic feet for Class IV., 36·5 cubic feet for Class V., and 65·5 cubic feet for Class VI., the supply of overwood would amount to

$$8{,}067 \times \cdot 02 + 4{,}034 \times 2\cdot 0 + 2{,}420 \times 7\cdot 2 + 1{,}513 \times 18\cdot 0 + 968 \times 36\cdot 5 + 672 \times 65\cdot 5$$

$$= 161 + 8{,}068 + 17{,}424 + 27{,}234 + 35{,}332 + 44{,}016$$

$$= 132{,}235 \text{ cubic feet.}$$

In this manner we may find the normal number of trees to be maintained, or established, and their ideal cubic contents. It is also necessary to know the heights, or diameters, of the test-trees of each class, in order that the height, or diameter, of a tree may be used to fix its age-class when working the forest.

If the yield is to be given in cubic feet, it is necessary to make a very careful and comprehensive estimate of the contents and increment of the overwood. The amount to be cut yearly in each class may then be fixed by the formula

$$Y = I + \frac{Q - Q'}{a}$$

when I represents the actual yearly increment of the series: Q the actual, Q′ the normal, supply: *a* the term of an age-class, which should correspond to the length of a period. If the forest is not normal as regards its age-classes, it must gradually become so, provided the estimate of increment and standing-stock be correct.

The data of this calculation are, however, very difficult to determine, and the usual, as well as safest and most simple plan, is to fix the number of trees of certain height- or diameter-classes to be cut annually, so that the uncertain elements, cover *and increment, shall not be brought into the calculation,* except as rough guides to the number of trees which should be maintained. The maintenance of a fixed quantity of overwood of each age-class is thus rendered a comparatively simple affair. If the age-classes are not normal, the object of the organization will be to make them so by suspending cuttings, or by reducing them below the normal rate until the desired object is attained.

The system of determining the number of trees of each age-class to be cut by a hard-and-fast rule is not likely to enable the proprietor to utilize his land to the greatest advantage. The number of standards of a given age which may be most advantageously maintained cannot be fixed arbitrarily without loss. All large areas consist of parts of various degrees of fertility, and the better stations will generally be capable of holding more overwood than the poorer ones. In one place it might, therefore, be to the owner's interest to grow more standards than the fixed number, in another less. Nevertheless, in extensive forests of this kind, order and regularity of yield may be of first-rate importance, and owners of large estates may sometimes prefer to sacrifice the chance of a certain amount of additional gain *in order that the sustained yield of their forests* may be practically secured by strictly prescribing the quantity of standing-stock to be maintained in each class.

2. Forest managed by the primitive method.

A normal forest worked on the primitive system is very similar to the overwood in stored coppice, only it is more densely stocked. If the revolution is fixed at 100 years, and there are 1,000 acres of forest, the yearly coupe will be equivalent to $\frac{1000}{100} = 10$ acres, and there will be a regular series of all ages from 1 to 100 years, occupying an area equal to 10 acres each.

But, unfortunately, in this case, as in that of the overwood of stored coppice, there are no means of knowing the area actually occupied by the oldest, or any other, age-class, because trees of all ages are mixed up together ; and affectations, which are the best safeguards against excessive or insufficient cuttings, cannot, therefore, be constituted. The estimate of yield must, consequently, be based on mass and increment. But it is evidently practically impossible to estimate the number or quantity, let alone the growth, of the trees of the youngest age-classes, and it is, therefore, necessary to be contented with a much less thorough examination than is possible in the case of regular forest, or even stored coppice.

The best plan in regulating this kind of forest, is to confine the attention to a few of the oldest classes, and to estimate their contents and growth by measuring trees on test-areas, or on the whole forest-area if greater accuracy is required. If the revolution of a forest is about 100 years, an estimate of the standing-stock of the two oldest classes comprising, say, trees from 50—100 years old, will suffice for most practical purposes.

If the estimate is confined to test-areas, as will generally be the case, a long narrow form is the best to give them, as in very irregular forest that shape is most likely to give satisfactory results.*

Before measuring the trees, the first point to decide is, the size of the smallest tree, as indicated by its diameter at breast-height, to be taken into account. Supposing it were decided in a given case to begin at 18 inches' diameter, and to class together all trees of 18—20 inches, and again all those 20—22 inches in diameter, and so on, proceeding by differences of 2 inches for each class, and neglecting all trees under 18 inches. When the particulars of all measurable trees on the area taken up had been booked, representative trees of each class should be felled, and their heights, contents, ages, and increment determined, and finally the contents of each class calculated.

The quantity and rate of growth of each class would then be

* The following method of estimating the proportion of the standing-stock of different classes on test-areas in large forests was published some years ago, by M. de Béranger, in the *Tharandter Jahrbuch*. The working party consisted of two men with a surveyor's chain, two diameter-measurers, an ordinate-measurer, and a clerk. The chainers move in any required direction, measuring the linear distances travelled, zigzag or straight. The ordinate-measurer walks along the chain and swings to the right and left in advancing a staff 10 feet long, one end of which is kept vertically over the chain. The diameter-measurers measure and call out the diameters and species of all trees within the radius of the circle swept by the staff, and these diameters are noted in a field book by the clerk. The area examined, in square feet, will of course amount to $20 \times l$, if l represents the distance in feet travelled as measured by the chain, and practically insignificant differences owing to the lines not being straight, when such is the case, are neglected.

known, and it would be possible to calculate how long the oldest classes would have to last until the younger should become exploitable.

Supposing, for instance, that we find in a forest

Class	I.	1,500 trees of diameter	18–20	inches.
,,	II.	1,500 ,, ,,	20–22	,,
,,	III.	1,500 ,, ,,	22–24	,,
,,	IV.	500 ,, ,,	24–26	,,

and that the most advantageous revolution is that which produces trees of about 23 inches diameter, we should have, according to the estimate, 1,500 exploitable trees, and if the average rate of growth in diameter of a tree of the class 20—22 inches is 1 inch in 10 years, it would take the 1,500 in that class 20 years to become exploitable, and we would have to husband the resources of the two oldest classes, so as to make them last that time. If, for example, the average tree of the penultimate diameter-class contained 120 cubic feet, and had an increment of 3 per cent., and that of the last contained 160, with an increment of 2·5 per cent., the material yield of the next 20 years would be—

		Cubic feet.
1,500 trees, with contents, ...	120 × 1,500 =	180,000
Add increment for 10 years at 3 per cent.,	=	54,000
500 trees, with contents, ...	160 × 500 =	80,000
Add increment at 2½ per cent. for 10 years,	=	20,000
Total yield for the period,	...	334,000

The average annual yield for the period would be, $\frac{334000}{20} =$ 16,700 cubic feet ; to which would have to be added the estimated returns from thinnings and windfalls, in order to obtain the total estimated yield.

This estimate of yield would, of course, require modification if there were found to be a considerable excess of old timber, or if the lower size-classes were insufficiently represented. During the examination of the forest the organizer would always obtain a rough idea of the relative proportion of the trees of inferior size-classes ; but it is always within his power to include comparatively small trees in his examination if he should think such a step necessary.

A more simple plan, which is frequently resorted to, is to express the yield in trees. In that case the increment would have to be neglected. In the last example, for instance, there are 2,000 exploitable trees which would have to last 20 years, 100 might, therefore, be cut yearly with safety.

Even in forests organized in this rough-and-ready manner, it is advisable to have some sort of method in the working, and to decide, from period to period, which compartments are to be

exploited and how much produce is to be taken from each one. Each compartment should then be worked out in rotation, and given complete rest during the remainder of this period, so as to admit of its being properly protected during the years of reproduction. By this means, regeneration can be effected much more easily than when the cuttings are spread over the whole area, because, whenever wood-cutters, herdsmen and others are allowed the run of a considerable tract of forest, they cannot be properly supervised, and are apt to set fire to the jungle, or to allow their cattle to graze down the young growth. Naturally, too, re-stocking can be more carefully attended to when only a comparatively small area is taken in hand at a time. For these reasons, and in order to facilitate stock-taking and the removal of produce, compartments are just as necessary in forests managed by this method as by any other, although they may generally be made larger than in series subject to the methods of regular cuttings.

A serious objection to the selection-method is that it renders the regeneration of the forest difficult and hap-hazard; it is, moreover, a wasteful system, and one that does not admit of the sustained yield being determined with certainty. Notwithstanding these disadvantages, it is well suited to certain conditions, as, for instance, when forests, whose produce is of little value, can only be worked at a profit if treated very extensively. Again, to countries which are only just commencing to preserve their forests, it offers a simple, expeditious, and easily-understood means of regulating the yield, and of keeping cuttings sufficiently within bounds until such time as it may be possible to introduce superior methods. Sometimes, again, it is advisable to treat protective forests, by this method, in order to avoid the gaps which arise temporarily in the working of regular forests, and which might in some situations give rise to landslips, or endanger regeneration, or the safety of the surrounding crop.

(*To be continued*).

A CHAPTER ON SOILS—IN THEIR BEARING ON THE NATURAL REGENERATION OF SAL.

In wandering through the sál forests of Bahraich, we notice so many startling interruptions to otherwise vigorous forest growth, so many, at first, unaccountable differences in the vegetation covering confined tracts of country that, having also in view occasional strange anomalies between the character of the stock and that of the soil supporting it, we find ourselves forcibly attracted to a study of the latter subject.

Before making any special allusion to the character of the different soils met with in the Bahraich sál forests, and to the

manner and degree in which sál reproduction is influenced thereby, it is best to explain all those circumstances and conditions of soil that, viewed through the medium of my personal experience only, would appear to militate for or against the successful and abundant natural regeneration of the species: and since it is now a well-established fact that forests are chiefly affected by the physical properties of the components of the soil, rather than by their chemical composition, I shall, throughout this article, confine my remarks to the former side of the question.

If, selecting a locality noted for the happy results that attend the natural reproduction of sál on its surface, we dig up a seedling of that species—say eight months old—and examine it, the first thing that strikes our attention is the inordinate length of its root, which will be, perhaps, as much as 3 feet long.

We next observe the thread-like tenuity of this root, its delicacy of texture, and general friability. Its whole structure appears to us, in fact, such as must supply an index to its requirements, to its preferences and to its dislikes. We can, indeed, well understand that an organ so soft, so delicate, was not intended by nature for purposes of attack, for any sort of struggle with the matter in which it should find itself imbedded. Its powers of penetration should be extremely limited. And is this not also the case? The soils chiefly affected by sál, what are they? Without exception, porous, loose, unresisting mediums—gravels, sands, boulder-soils—soft yielding substances, or at least soils with alternate openings through which the root of the sál seedling can make its downward progress without more fatigue than is involved in a brief deviation from the direct line of descent.

We have, again, no difficulty in perceiving that the moist and thin epidermal covering of the root before us is but a poor substitute for that tougher coat with which Providence encases the extremities of such plants as are intended by it to fight against drought, and that other extreme of excessive humidity. In its natural habitat of loose, well ventilated soils, the sál seedling has, undoubtedly, to contend, at times, with very considerable difficulties in the way of obtaining a sufficient quantity of moisture. But that it is able to bear a great deal in this way is sufficiently obvious from the often luxuriant crop of sál seedlings observed by us on the crests of exposed mountain ridges—stony grounds drained on either side by precipitous descents, and unsheltered from the heat of the sun, here intensified by the effects of radiation. On the other hand, this difficulty of procuring to itself food, in the absence of the chief vehicle of its supply, is minimised in degree by the natural facilities for descent afforded to the root in this class of soils, and by its predisposition to avail itself to the utmost of these advantages. It must also not be forgotten that there is one circumstance more dreaded by the sál seedling

than comparative want of moisture, and that *is a high temperature.* Moisture and a low temperature are not necessarily interchangeable terms. The loose soils affected by sál have pre-eminently this quality that they are non-conductors of heat, while the dense soils in which the sál is noticed not to reproduce itself freely are, on the contrary, powerful transmitters of the same element. This conductivity of the soils is a matter of extreme importance, in my opinion, to the Indian Forest officer. It explains in part, the less deadly effects of fires on gravelly soils, the greater fatality of the same on stiff loams. Above all, it explains the death of those multitudes of sál seedlings that, in denuded soils of a distinctly clayey nature, take root, year after year, only to wither up on the advent of summer. Is not the vigorous reproduction on exposed rocky, or gravelly, ridges already referred to, greatly assisted by the freshness, as regards temperature, of a soil, the constitution of which is opposed to the transmission of heat into its interior? If any one will go to the trouble, on a hot summer's day, of excavating into the sides of a sandy or gravelly bank—say 3 or 4 feet from the surface—he will be surprised to find how cold to the touch the walls of this cavity will appear to him.

To the Forest officer there could be no greater anomaly, at first sight, than the State forest of Bhinga, in Bahraich. The preponderating species here is sál, but the soil itself is about as stiff a loam as could be found in a day's walk. Over large areas there would appear to be absolutely no vegetable-soil whatever, while, on the average, the latter is only a few inches deep. A tenacious, ochrey, intractable clay of great depth, and unrelieved by more than a few particles of "kankar" gravel, such is the subsoil, and such is only too often the surface-soil itself. The question is how can sál have ever reproduced itself freely under such conditions—conditions reconciling themselves so ill to what we know of the requirements of the species. That sál did propagate itself in this forest, and even flourish splendidly, is obvious from the great number of very fine trees that we meet with. However, to one knowing the circumstances peculiar to a healthy sál forest, and who shall have examined the present locality with care, there will be no great difficulty in solving a problem that is, after all, a sufficiently simple one. To him it will be evident that sál never did reproduce itself freely in this soil, that the soil has undergone a great change. And, in fact, numerous as old trees of the species are, we meet with no fresh evidences of successful sál reproduction; indeed we see hardly a sál tree of recent age. On the other hand, we cannot help perceiving that there is a plentiful young growth of such species as have no objection to, even if they have no decided preference for, soils of a dense constitution. Among these stand foremost in Bhinga the Ebony (*Diospyros Melanoxylon*), the Bael (*Aegle Marmelos*), the Sitána (*Zizyphus xylopyra*), the Haldu (*Adina

cordifolia), the Kúsum (*Schleichera trijuga*), the Bahera (*Terminalia belerica*), the Asna (*Terminalia tomentosa*). Apparently, the whole forest is in process of rapid transition. Familiar as we are with the classes of soil for which the sál shows a predilection, a predilection so great as to border on vital necessity—as is well instanced in the always sharp outlines of sál forests—we have no difficulty in understanding the great change going on before us, or in realizing how very different all this soil must formerly have been, and that at no very remote period of time.

After spending a few months of the rainy season in this forest, and carefully observing the phenomena attending the germination of the sál seed, and the subsequent development of the plant, we begin to appreciate all those adverse conditions that militate so fatally in the locality against the chances of young sál life. The nature of these conditions has already been dwelt upon in my references to the baneful influences of very clayey soils on the sál seedling—influences which would appear to be exaggerated, in the present case, by every unfavourable circumstance that could well be imagined. Among the latter I shall only mention excessive grazing, and its result of exposing an already too denuded surface to all the fierce heat of an Indian sun. The surface of the ground, in Bhinga, is, in most places, so indurated, and the soil so dense, that very much of the sál seed perishes in the unabsorbed waters that are common to that period of the year. Such seed as take root have the appearance, in the resulting young plants, of being healthy and vigorous so long as the monsoons last. Examination of the root, however, brings to light, in every instance, one fatal shortcoming: it has not gone deep enough. Its extremity will often be found to have rotted. In all cases it will be seen to have swollen and become coarse at the expense of that linear development so characteristic of the healthy subject. Knowing as we do the furnace-like heat to which the upper layers of this soil will be exposed later on, we already foresee that which will surely happen—the universal withering up of all these sál seedlings.

A small extent of the Bhinga forest—some 5 square miles—has been strictly preserved from pasture for many years past, and here alone do we meet with any sál seedlings of more than a year old. In this closed tract the forest has grown more dense, much more dense, and the surface-soil is being gradually loosened and modified by adulteration with vegetable matter. Still, the improvement in the soil, under these more favourable circumstances, is not yet sufficiently advanced for the healthy development of the sál seedling, which survives in the form of a weakly plant, apparently without any certain future before it.

What is the nature of the great change that the soil in Bhinga has undergone since those days when sál prospered there, and allowed of no rivalry?

In many parts of the forest, where the subsoil is exposed, the vegetation scanty, and the ground on an incline, we have little difficulty in perceiving the effects of erosion.

Nobody visiting Kukurdaree, or the southern and western limits of the forest—for say half a mile inwards—can fail to be struck with this circumstance. The few trees here met with, even the thorns themselves, stand on cushions, little island knolls of their own, that their spreading tops and encircling roots have preserved from the general wreck around.

But the almost level configuration of the ground that distinguishes the greater portion of the Bhinga forest makes it impossible for us to suppose that the original soil can have been removed by the agency of water. Yet either there has been removal of the soil—complete, or partial only—or there has been a further disintegration or decomposition of its elements. The great depth and uniformity of the clayey subsoil forbids, however, the theory that there can have been any change going on in its surface layers of the nature of disintegration or chemical modification. Look around us as we may, there would appear to be but one solution of the question, namely, that the present vigour of the soil was, in the better days of the forest, neutralized by the excessive quantity of vegetable matter with which it was impregnated, and by the thick coating of mould that covered its surface. And, if we examine the circumstances of the soil in healthy portions of the Motipur and other forests of sál in this district, and study the visible improvements already being effected in such parts of the Bhinga reserve as have been long closed to cattle and fires, we are at once fortified in this belief. Over large extents of Motipur and Chakia, the soil, now supporting vigorous sál growth, would be undoubtedly very stiff in quality, but for the large admixture, in its substance, of vegetable manure. It is my opinion, therefore, that we have in Bhinga nothing more than an instance of soil deterioration on a gigantic scale, a deterioration that has progressed slowly through generations of time, the inevitable consequence of unceasing destruction by man, of pasture, fires, exposure to sun and air, and the resulting exhaustion of *that only element of original fertility in this otherwise purely argillaceous soil.* Restore this vegetable manure, and, in my opinion, you restore the forest at one and the same time. But this restoration signifies no more fires, no more pasture, no more fellings, no more removal of produce—not even grass—for two score of years. Who will say yea to all this? Seeing how rapidly the unclosed tracts of this forest are being denuded by the privileged populations, shall we not soon hear a great cry on their part to be allowed into the protected areas? And will Government resist the appeal of the local authorities when this *most sure* event shall come to pass? The formation of vegetable mould, that great neutraliser and destroyer of intractable qualities in the

soil, that grand fertilizer of its physical properties, is only rendered possible in humid surroundings, under circumstances where evaporation is a slow process, and the locality sheltered in a high degree from both sun and wind.

But if, in the Bhinga forest, fires have devoured the mould desiccated by exposure, and the free inlet of sun and air has made further accumulations of it impossible, if the hitherto highly impregnated soil has been bereft of all its remaining riches in the ordinary course of vegetable life, a most formidable agency of ruin and destruction remains to be described. I refer to the ever-busy colonies of white-ants, whose numerous hillocks—sometimes as many as fifteen to the acre—constitute one of the most conspicuous features of the Bhinga forest. Neglecting the almost certain fact that the termites consume a considerable quantity of the forming vegetable mould, these only too industrious insects are mischievous in quite another direction, and on a much more serious scale. Each one of these tiny Neuroptea is but a living pump, and by the united force of their myriad numbers, an immense quantity of unkindly subsoil is annually brought to the surface, to be there spread out, wherever the protection of the neighbouring trees is deficient, into even sheets of a plastic and impenetrable cement—a soil so inhospitable that, until much diffused in the progress of years, even the lowliest herbs cannot grow upon it. An observing visitor to the Bhinga forest will not fail to notice the many blanks, from a few hundred square feet to acres in extent, which characterize it. These void spaces bear many points of close resemblance to one another in the generally barren nature of the soil, its white coloration, and the numerous evidences of extinct and living ant-life—evidences that range from the not wholly demolished hillock to the white circular deposit of unusually cement-like earth. Before walking very far inside the Bhinga reserve, the observing stranger will descry this process of soil deterioration going on in all its different stages, from the truncated cone just attacked by the advancing monsoons to the three or four mounds littering with their detritus half an acre of ground. Wherever we proceed, we notice, at short intervals, either towering ant-hills, or the evidences of their past existence, and it is impossible for us to neglect the immense importance of the part played by termites in forest economy.

I have now done with the subject of soils in so far as the Bhinga forest is concerned. It has been treated of at great length, not only because of the great extent of this Government estate—over 60 square miles—but because of the important deductions that follow from a knowledge of its circumstances.

Considerable tracts of other Government sál forests in Bahraich are in like case with that of Bhinga: witness those portions of the Sohelwa forest that lie off Bhagoratál, Bilaspur, and Gub-

bapur-Kulán; witness the whole easterly half of the Chakia forest, and some 10 square miles of the Motipur sál forest extending from Dharmapur all the way to Kharia. Much of this deteriorated soil in Chakia, and almost the whole of it in Motipur, is the result of active erosion, whereby the denuded soil is being swept away in annual increments. The fearful effects of this agency of destruction are wonderful and characteristic in the regions of the Motipur forest already referred to. It need hardly be said that all these ruined tracts border on cultivation, and that the hand of man is seen, as the original cause, in each instance of ruin.

Elsewhere in Bahraich, a more sandy constitution of the soil has counteracted many of the evil influences that have been at work. But since even sandy soils are liable, on level surfaces, and under constant pressure, to assume much of the density of purely argillaceous mediums, we are not surprised to find reproduction of sál very backward, very unsatisfactory on the extensive flats that make up so much of the Gubbapur and Murtiha blocks, heavily grazed over as they are. All those fine patches of sál forest which relieve the otherwise very sickly appearance of the stock in Murtiha, arise from the sides of deep basins, or occupy the entire superficies of a few gentle depressions—situations which permit of the excess of clayey particles being washed away, and of accumulations of loose soil being formed from the erosion of neighbouring high grounds. These rich basin forests are also very characteristic of the Nishangara block, although they there cover much larger areas of ground. Peculiar also to both blocks is the barren denuded appearance of the high-lying tracts intervening between these successive hollows, wherever the ground is rapidly undulating. The subsoil of a hard indurated loam is there superficial, and such little soil as results from the process of disintegration, finds its way into the bottoms on either side, as already explained. The tendency of sandy loams to become very dense on their surface, when exposed to the sun, and subject to much pressure, is a very natural circumstance on level grounds. Because the waters of the monsoon bring the clay on to the surface where it is deposited in a very pure state, to be hardened by the sun and by the feet of cattle into the consistence of a brick. On hilly ground, and on all slopes, this clayification of the surface is counteracted by the washing agency of the waters in their course to the lower levels, and by the facilities afforded for such action. For this reason also, grounds that are inclined, unless constituted of pure clay or rock, are very loose, open soils—at least on their surface.

When we ascend from the low grounds of Sohelwa, with their stiff loams of the Bhinga type, we immediately come on to the usual sub-Himalayan formations of gravel, sand, and boulders, all soils most suitable to the natural regeneration of sál.

In certain parts of Nishangara and Murtiha, we come across

deep banks of almost pure sand, in which the particles are principally mica, and which have evidently been deposited in their present position by the action of the Koriala river, when the latter flowed, as it undoubtedly once did, immediately under the present high banks which so strongly define the limits of this great sál forest to the north and west.

There is a characteristic bank of this alluvial deposit within 50 yards of the Nishangara rest-house. Perfectly loose, and without any cohesion, but strongly impregnated with vegetable matter, the very finest natural reproduction of sál is met with on this class of soil.

Off Bachkhall, and in many other parts of the Gubbapur block, in Sohelwa, we note rather low-lying bottoms that are subject to the periodical washings of neighbouring very ill-defined water-courses. As a consequence, the clayey particles of the soil have been here all carried away, leaving a very pure sand behind. These localities are always densely covered with young forest of pure sál. We observe again how, in Gubbapur, where ravines interrupt the level surface of extensive plateaus, the banks and broken ground subtending these ravines are similarly well covered with young sál trees. The cause is always the same—the washing, *in moderation*, of a stiff, dense soil, and the removal of that excess of clay which imparts these unsuitable qualities to the soil—unsuitable in so far as sál is the species concerned, sál which must have an open soil, and prefers it to be loose to the verge of non-cohesion.

E. P. D.

A VISIT TO THE CITY OF CANTON.

WHILST passing Hongkong last April *en route* for Japan and America, I had an opportunity, whilst waiting for the sailing of the P. and O. steamer, to pay a flying visit to Canton, and some account of that curious city may be interesting.

The voyage to and from Canton from Hongkong is easily performed in about seven hours each way, by means of a fine line of river steamers, built on the model of the American river boats, one of which leaves Hongkong and Canton at 5 p.m. each evening, so that in going up the traveller sees the lower portion of the river, and in returning the upper part can be examined by day light. The lower half of the Canton river is not very picturesque, and the low hills and fields were green and pleasant looking at the time of my visit, but generally denuded of tree vegetation. After passing the remains of the famous Boyne forts, near which others of a still more formidable nature are now being constructed, the scenery becomes much more interesting, and continues so till Canton is reached, the whole distance from Hongkong being 75 miles.

At a place situated about 10 miles below the city we found the river blockaded by means of a line of piles and boulders, this precaution having been taken in connection with the late French difficulties, a small opening for traffic only being left, through which the steamer passed.

The banks of the Canton river are, as a rule, low, and wherever the soil is suitable numerous paddy fields are seen, which were being carefully manured by means of liquid manure brought down in boats from Canton. I observed that efforts were being made to increase the area of these fields by reclaiming waste land from the river, by means of extensive dykes and embankments.

At various places along the banks there are numerous low hills, which are generally surmounted by Chinese temples or "Joss" houses, surrounded by fine groves of pines, bamboos, and cotton-wood trees. There are also several stately pagodas scattered over the country near the river, which, however, do not seem to be much cared for, as numerous shrubs and trees are growing out of the masonry. From 10 to 15 miles distant from the river on each bank, ranges of mountains of considerable elevation are observable, which are generally bare of forest vegetation, but a few patches of what appeared to be pine forest were visible here and there. There seemed to be a considerable traffic on the Canton river, and many steamers and junks of all sizes and descriptions, both for war and peaceful purposes, were passed.

The neighbourhood of the city which occupies both sides of the river, simply swarms with small boats of all kinds ; there being in all a "floating population" of about 65,000, the term being used in its literal sense. Many of these boats are merely used as habitations, the occupation of the owners being that of tending ducks and geese, or carrying on various kinds of small trades. These are generally called "flower boats," but I was told that the term ought more strictly to be applied to those boats devoted to pleasure trips.

Early next morning I started, accompanied by a trustworthy guide, to see the sights of this famous city, a brief account of which I shall now attempt to give.

The streets of Canton present a most unique and remarkable appearance, being only about 8 feet wide, and the whole space between the houses and 8 feet above the roadway is literally crowded with sign-boards of all colours, either suspended or projecting from the walls at right angles to the streets, the whole being mixed up with variously coloured lanterns of all shapes and sizes.

The population of Canton being about one-and-a-half millions, the streets of course team with Celestials, which circumstance, however, did not prevent the chair coolies from shuffling along at a fair pace, shouting "Ah ho," and the manner in which they

managed to cut the sharp corners without coming into collision, was most creditable from a piloting point of view. All Chinamen seem to stick rigidly to their national costume, and considering that no police were visible, perfect order seemed to prevail.

A considerable number of Chinese ladies were met with in the streets, and I observed several with feet not exceeding 4 or 5 inches in length and about $1\frac{1}{2}$ inches in breadth, which circumstance, however, did not prevent them from hobbling along in a fairly active manner. In some parts of the city of Canton the shops are of a superior and pretentious description, and consist of those of lace, silk, fan painters, carvers in ivory, wood, and tortoiseshell, also jade stone and lacquer-ware establishments, besides which there are of course endless others of a more practical description, such as lantern makers, butchers, fish shops, blacksmiths, carpenters, &c., all of which seemed to be driving a roaring trade. One peculiar feature of these shops is that every tradesman makes his calculations on a kind of square plate shaped something like a gridiron, with a number of small balls running up and down the ribs, by the aid of which contrivance the most abstruse calculations can apparently be worked out.

In traversing the city I observed numerous wood and fuel depôts, a kind of pine, probably (*Pinus Thungbergii*), being most in use, which together with bamboos enters largely into the construction of Chinese houses.

The fuel most used consists of hard woods, and is offered for sale in neat bundles of about 10 seers weight, the billets being split and sawn into 18-inch lengths. All charcoal, principally in large pieces of not less than 4 inches in diameter, was made up in neat bamboo or grass baskets of various dimensions.

The principal temple or "Joss" house visited was that called Honan, which is constructed of wood, but the general appearance is not very imposing. This temple contains various gigantic statues of Buddha, made of wood elaborately gilt, besides which there were various satellites in the form of demons of all colours.

This temple is surrounded by a fine grove of *Ficus* trees, and in a neighbouring building 12 sacred pigs were shown, all of enormous dimensions and much too fat to move.

We next visited the residence of a private Chinese gentleman, with whom the guide seemed to be acquainted, and I was much struck with the neat internal arrangements and decorations of the mansion.

Amongst various chambers shown, I noticed one devoted to the smoking of opium, and specially fitted up for that purpose. One side of this house was occupied by a lake and garden decorated with flowers, shrubs, rustic bridges, and trees cut into various fantastic shapes.

We next inspected what is called the temple of 500 Genii, where there are four immense statues of Buddha supported by 500 saints, mostly of ferocious aspect, amongst whom there is one representing the famous Venetian traveller Marco Polo.

From thence we proceeded to the examination hall, where the examination of candidates for Government appointments, degrees, &c., takes place once every three years.

The importance of this contest may be judged of from the fact that the compound of the hall is divided into 10,000 separate cells, to which the candidates are condemned to solitary confinement for two days and nights, till they complete their papers, which consist principally in writing elaborate quotations from ancient Chinese authors. Notwithstanding the careful precautions taken, all kinds of abuses and frauds are said to take place, and sometimes a wealthy candidate, by means of judicious palm-greasing or otherwise, can manage to send a substitute, who of course passes with *éclat*.

From the examination hall we proceeded to the city wall, along which are planted a most antique collection of rusty cannons, which if fired would doubtless prove more dangerous to the defenders than to their enemies.

From a five-storied pagoda situated on the highest point of the walls a fine view of the city and surrounding country is obtained.

The vicinity of Canton consists of an undulating country, the valleys and low lands being utilized for rice cultivation and vegetable crops, a most elaborate system of irrigation and manuring being of course practised.

The low hills in the immediate neighbourhood of the city are employed as cemeteries, and immense areas are covered with graves, which the Chinese appear to construct in a circular form, something in the shape of a horse-shoe.

All the other hills are bare of forest vegetation, and few trees of any kind were noticed in Canton or its neighbourhood, with the exception of cotton trees (*Bombax?*), pines, Persian lilac, *Ficus* of sorts and bamboos.

We next visited what is called the "temple of horrors" situated in the most populous part of the city, which consists of three or four large vaults or cells filled with plaster figures representing the trial, torturing and execution of criminals, after various barbarous methods.

This temple I was told is considered specially sacred, and numerous devotees were engaged in their devotions, one of the most important rites of which apparently consisted in lighting a "Joss" stick, which may be described as a kind of taper. I noticed that the immediate vicinity of this temple swarmed with fortune tellers, card sharpers, quack doctors and miscellaneous vendors of every description, all of whom seemed to be actively engaged in swindling the unwary. A Mandarin's court

was next visited, when various prisoners accused of thefts, &c., were being tried.

These men were brought in with chains round their necks, and placed on their knees before the august Magistrate, who soon disposed of them in a summary manner. One man who either refused or failed to make an expected confession, was suspended by the thumbs and big toes, which torture he endured for about twenty minutes, when he fainted, upon which the Magistrate ordered him to be let down, which the jailors did in no very gentle manner, and when we left the court the unfortunate wretch was still lying insensible on the floor.

We next visited the neighbouring jail, which was crowded with prisoners of forbidding aspect, and the general conservancy and lax discipline of the establishment would rather astonish the most benign Superintendent of an Indian jail.

From the jail we proceeded to the execution ground, the space devoted to this important purpose being of the most limited extant, probably not exceeding 300 × 100 feet, and at the time of my visit the space was occupied by potters busily engaged in making earthen stoves, basins, &c. The executioner, who seemed to be on the look out for travellers and "bakshish" soon appeared on the scene, and with many "salaams" and smiles exhibited his sword, which I found to be a heavy murderous looking weapon. I was informed that about a month before my visit this man decapitated as many as 23 prisoners one morning in succession, the whole tragedy having been completed in about half an hour.

It may be observed that in China there is said to be a class of beggars who volunteer to have their heads cut off as substitutes for others, on the payment of a moderate sum, which goes to his relatives and friends, so that if a criminal can raise the necessary funds he can generally escape the final penalty of the law.

Having "done" all the principal sights of Canton, we next proceeded to the foreign settlement, called Shamen, situated on a small island on the right bank of the river, where all the Consuls and principal merchants reside, glad to escape from the odoriferous city, the smells encountered during the day having been somewhat overpowering.

My stay at Hongkong having been extremely limited, I found that I had no time to visit the planting and other interesting forest operations described from time to time in the "Indian Forester." From a distance however, I observed on the hills surrounding the harbour, several extensive areas apparently planted up with pines and other trees in lines running perpendicular to the slopes, some of which appeared to be about 12 feet high, and seemed to be flourishing. Judging from the nature of the climate and appearance of the soil, the success of planting operations at Hongkong is probably not

nearly so uncertain as in most parts of India, and owing to the frequency of showers the dangers from fire must be much less.

There is apparently very little natural forest growth on the Hongkong hills, but a few patches of pines, probably *Pinus Thungbergii*, are seen scattered here and there.

From the casual look I had of the town of Hongkong, it seems to be a thriving place, with a magnificent harbour crowded with the shipping of all nations, and it was most satisfactory to notice that steps are now being taken to erect formidable fortifications. The town is well built, and even the Chinese quarter is clean and prosperous looking.

The Police force is mainly composed of a fine body of Sikhs, in addition to which there are a limited number of European and Chinese constables.

I must not forget to mention that I made a point of visiting the famous "happy valley," which is easily reached by Jinrickshaw in about half an hour, this conveyance being now the common mode of locomotion in China and the East.

This beautiful spot consists of a valley surrounded by spirally wooded hills, the level ground constituting a race course, whereas the lower slopes of the hills have been used for the purpose of a cemetery since Hongkong was occupied in 1841, and thousands of the former inhabitants now lie at peace there, surrounded by a most picturesque combination of pines, bamboos, cottonwood trees, mangoe, *Ficus auracaria*, and other forest trees, as well as flowering shrubs of great variety.

E. McA. M.

TIMBER MEASUREMENT IN UPPER BURMA.

THE system of timber measurement and calculation of Burmese tons (*athas*) in Upper Burma is very curious, and will, I think, be of interest to Forest officers in British Burma. It is in general use here, and, to one new to the province, is very puzzling, and no reason can be given by the Burmese for the inproportionate relations between logs of different sizes to the standard of cubic measurement, except that of long established usage.

Linear measurement.—The table of linear measurement is very simple. The *taung* (cubit) is the standard. It is divided into four quarters, each called a *sôk*. Every Burman when about to measure round timber, manufactures his own *taung*. A bamboo stick is smoothened with a *dah*, and sixteen rupees are laid side by side on it. The portions remaining on both sides of the rupees are carefully cut off, and the *taung* is ready. A straight mark is made at every four rupees for the *sôks*, and a cross mark at every other two rupees for the half *sôks*. The *taung*

measures a little more than 19 inches. In very rough measurement, the length from the elbow joint to the tip of the middle finger is supposed to equal a *taung*. In that case *sôks* are not quoted, but instead there are *twa-s*, *meik-s* and *let-thit-s*. A *twa* is a span; a *meik* (about 6 inches) is the length from the last joint of the little finger to tip of the thumb, the fist being closed tightly, and the thumb stretched out as much as possible; a *let-thit* is a finger breadth.

Cubic measurement.—The *atha* or Burmese ton is the standard of cubic measurement. The following is the table :—

2 annas (pè)	=	1 *mú*.
10 *mús*	=	1 rupee (*kyat*).
3 rupees	=	1 *atha*.

The rupees and annas of the above table must not be confounded with the coins of the same name. In most Burmese industries, the particular standard is divided into rupees, *mús*, and annas, and it bothers one not a little when the value of an article is required, to calculate from rupees (of measurement, weight, &c.) to rupees (of money).

Manner of measuring logs.—All actual measurements of girth are carried on by means of split canes. Elsewhere logs are generally measured at the middle, but in Upper Burma the exact place of measurement is decided as follows :—

Length of log.	Place for measurement of girth.
12 *taungs* (18 feet), ...	3 *taungs* (4½ feet) from base of log.
15 „ (23 „), ...	4 „ (6 „) „ „
20 „ (30 „), ...	5 „ (7½ „) „ „

and so on, for every addition of 5 *taungs* in length, the girth is measured one *taung* further from the base.

The length is measured in the ordinary style, all logs from 12 to 14 *taungs* in length are classed as 12 *taungs;* from 14 to 19 *taungs* in length as 15 *taungs;* from 19 to 24 *taungs* as 20 *taungs;* and so on.

I may here add that it is not usual to cut timber of any size under 12 *taungs*.

The following is the procedure usually followed in measuring timber :—

The price of the timber having been settled on, as also as to who shall pay for the split canes, the buyer and seller arrive at the spot where the timber is lying, at the appointed hour. Each brings a man with him to assist in the measuring. The buyer's assistant marks out the exact place of measurement in accordance with the rule given above, and girdles the log with a split cane, pulling tightly at both ends. The seller's man then with a *dah* cuts the cane where the ends cross one another. The cut cane (now the exact girth of the log) is made over to

*the seller. In this way all the logs are girdled.** Each cane is now taken and bent into two equal lengths. The bent cane (half the girth) is then measured with the *taung* measurement stick, and the result noted in *sôks.*

Method of calculating "athas" or Burmese tons.—There is no fixed relation between linear and cubic quantities ; a *taung* is the standard of linear measurement, and an *atha* the standard of cubic measurement. A log of 12 *taungs* in length and 8 *sôks* in half-girth is considered to contain an *atha*, while another log 20 *taungs* in length, and of the same girth, though not twice the volume of the first log, is considered to contain two *athas.* If a Burman is asked why this should be, he says he cannot tell, except that it is a long established custom.

The following is the table for calculating Burmese tonnage:—

Measurement of half-girth.	Length of log.	Cubical Contents.			
		Athas.	Rupees.	*Mús.*	*Pès.*
3 *sôks.*	12 *taungs*	..	..	2	..
3½ "	"	..	..	3	..
4 "	"	..	..	4	..
4½ "	"	..	..	5	..
5 "	"	..	..	6	..
5½ "	"	..	..	7	1
6 "	"	..	1	..	..
6½ "	"	..	1	5	..
7 "	"	..	2	..	..
7½ "	"	..	2	5	..
8 "	"	1	..	..	..
8½ "	"	1	..	5	..
9 "	"	1	1	..	..
9½ "	"	1	1	5	..
10 "	"	1	2	..	..
10½ "	"	1	2	5	..
11 "	"	2	..	..	..

It will be noticed that for every increase of half a *sôk* in half girth above 6 *sôks*, 5 *mús* (half a rupee) is added to the cubic contents.

The above table is only for logs 12 *taungs* in length. All logs of longer length are *reduced* to logs of 12 *taungs* by adding to the half-girth or multiplying the number of logs according to the following rule:—

1 log of 15 *taungs* in length = 1 log of 12 *taungs* in length

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* This word is used in its ordinary sense, and not to mean the well-known operation on trees in Burma preparatory to felling.

increased in half-girth by one *sôk;* thus, a log of 15 *taungs* in length and 8 *sôks* in half-girth is equal to a log of 12 *taungs* in length and 9 *sôks* in half-girth.

1 log of 20 *taungs* in length = 2 logs of 12 *taungs* in length and of the same half-girth.

1 log of 25 *taungs* = 3 logs of 12 *taungs.*

1 log of 30 *taungs* = 4 logs of 12 *taungs*, and so on.

It will be seen from the above table how utterly out of proportion the calculations are.

The following is an example of how tonnage (Burmese) is calculated :—

In the Note-book it is noted—

No.	Half-girth.	Length.	Number of logs.
1	3 *sôks.*	12 *taungs.*	25
2	5½ "	15 "	20
3	6 "	15 "	18
4	6½ "	20 "	16
5	7 "	15 "	8
6	7½ "	12 "	9

These are *reduced* to 12 *taung* logs, and the *athas* calculated as follows :—

No.	Half-girth.	Length.	Number of logs.	Tonnage on one log.			Total Tonnage.		
				Athas	*Rs.*	*Mûs.*	*Athas*	*Rs.*	*Mûs.*
1	3 *sôks.*	12 *taungs.*	25	0	0	2	1	2	0
2	6½ "	12 "	20 } 52	0	1	5	26	0	0
4	6½ "	12 "	32 }						
3	7 "	12 "	18	0	2	0	12	0	0
6	7½ "	12 "	9	0	2	5	7	2	5
5	8 "	12 "	8	1	0	0	8	0	0
			Grand Total Tonnage, ...				55	1	5

No alterations are made to Nos. 1 and 6, and the tonnage is calculated direct from the table. Nos. 2, 3, and 5 being 15 *taungs* in length, one *sôk* is added to the half-girth; they, therefore, become 6½, 7, and 8 *sôks* respectively. No. 4 being 20 *taungs* in length, is considered equal to twice the number of logs of 12 *taungs*, and is added to No. 2, being of the same half-girth.

The above system of timber measurement will, for some time yet, be the system in general use in Upper Burma, and I write

this in the hope that when a Forest Department is properly established in Upper Burma, it will prove of use to the Forest officers.

MANDALAY, 8*th July*, 1886. C. INGRAM.

SEEDING OF BAMBOOS.

I HAVE read with great interest Dr. Brandis's notes on the two Himalayan hill bamboos. As no body has come forward to supply information on that subject, I shall try and give a few facts with respect to the different bamboos which have come under my own observation.

In 1881 all the graceful *Bambusa arundinacea*, which adorned the old parade ground and other parts of Dehra, flowered. This was noticed at the time in this Journal by Mr. Smythies and others. In 1883 I was working in the forests in the neighbourhood of Barmdeo-Mandi in Kali Kumaon, and noticed a number of dead clumps of *Bambusa arundinacea*, which had evidently flowered at about the same time as the Dehra ones. The ground near the old clumps was simply covered with seedlings about 4 or 6 inches high. This would seem to point to the Dehra bamboo belonging to the same stock as the Kumaon bamboo.

The young seedlings are making themselves conspicuous in most hedges in Dehra, and are now 6 to 10 feet high.

In Dehra most of the clumps died down immediately after flowering, but I know one case which proved an exception. In 1882 one clump sent up a number of new culms. These, however, flowered again during the present year, and there is as yet no sign of new leaf-bearing culms coming up. As another example of great vitality in certain bamboos, I may mention here that on the same road, along which the above mentioned clump was growing, a clump of *Dendrocalamus strictus* flowered in 1881, sent forth new but thin shoots in 1882. These flowered again in 1885, and now new scraggy and thin shoots are pushing up in the midst of the old clump.

With respect to *Dendrocalamus strictus*, although the flowering is not so general as with other species, yet large areas become fertile at one time. The curious point about the flowering of this bamboo in the Siwalik forests of the Dún and Saharanpur is that the fertility seems to spread onwards gradually and year by year.

For instance in 1883 most of the clumps in the Kharkhari block flowered. In 1884 the Maiapur block, Saharanpur division, became fertile. Then the Ranipur block was attacked in 1885, and this year 1886 the bamboo in Rauli block seeded.

Thus the seeding began in the south-east corner of the Dún, turned the corner of the Siwaliks at Hardwar, and fertility is now apparently gradually spreading westward along the southern face of the Siwaliks. It remains to be seen whether this gradual march will continue along the rich bamboo forests of the eastern and central ranges of the Saharanpur division. Elsewhere I have seen this species flowering only sporadically.

The *Arundinaria spathiflora* flowered in 1882 all over Jaunsar and Tihri Garhwal. This year I saw only very few live full grown clumps of this species, but nearly all the hill sides are covered with little 4 year old seedlings. I send a rough drawing of a seedling showing the small culms given out in three different growing seasons, and a fourth budding one (*see a, b, c, d*), *Fig.* 1.

The *Arundinaria falcata* flowered this year all over the hills of Jaunsar and Tihri Garhwal. Wherever I saw this ringal near Chakrata, Deota and beyond in the Sahlra forest, almost every culm was loaded with flowers. I give a small drawing (much reduced) of part of one of these culms, *Fig.* 2.

The *Dendrocalamus strictus* and *Arundinaria falcata* can, therefore, be considered to flower gregariously as well as sporadically, and there does not seem to be any reason to consider them separate from the other species on account of their mode of flowering.

In 1883 I was working in the hills of Jaunsar, and remember seeing a number of *Arundinaria falcata*, but none of them were flowering.

A. F. Broun.

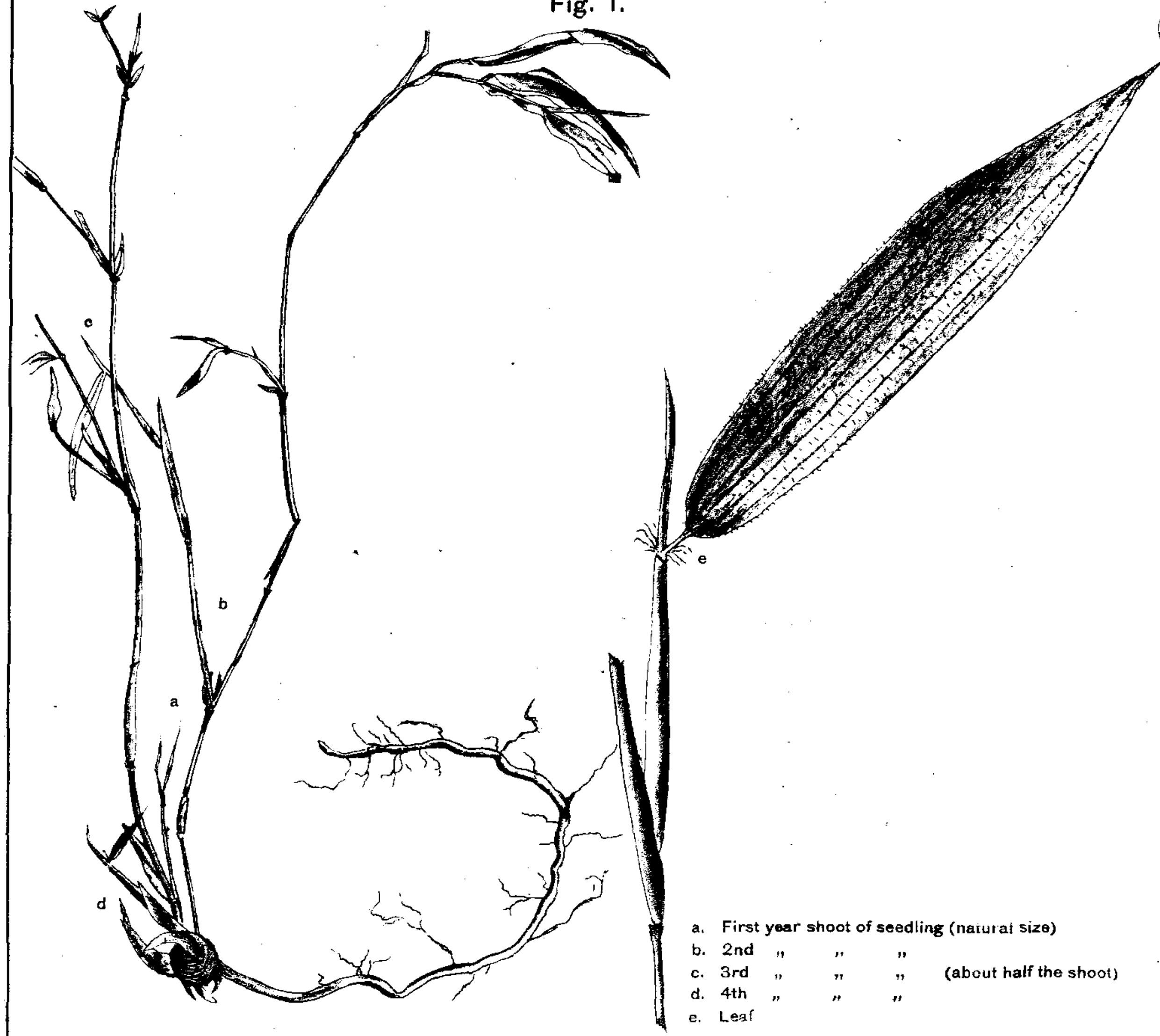
FORCE OF GERMINATING SEEDLINGS.

As an instance of the force of germination in seeds I may quote the following instance. I lately had occasion to construct some masonry boundary pillars in a khair forest, and I found that in a number of cases khair seeds had got mixed into the mortar which was spread over the surface of the pillars. The seeds in germinating had lifted up pieces of the hardened mortar from depths of often nearly an inch below the surface.

Q.

ARUNDINARIA SPATHIFLORA.

Fig. 1.



a. First year shoot of seedling (natural size)
b. 2nd " " "
c. 3rd " " " (about half the shoot)
d. 4th " " "
e. Leaf

ARUNDINARIA FALCATA.

Fig. 2.

a. Flowering culm (reduced).
b. " " (natural size)
c. Leaf "

Litho. T. C. Press, Roorkee.

THOS. D. BONA, Supdt.

IV. Notes, Queries and Extracts.

The Floods in the Punjab.—The first breach in the line is about four miles on this side of the Barara station; and three miles further on there are a series of breaks right up to the station. There is another large gap between Mustaphabad and Jagadhri, and the former station has been completely washed away. The up-mixed train, which left Jagadhri at 15-18 on Saturday, had to return to that station; and the up-Calcutta mail, due at 19-41, had to be detained there. The trolly party that attempted to pass the out English mails over the breaks was unsuccessful, and, after working all night, had to return to Umballa with the mails on Sunday morning. At first it was thought that the mails would have to be sent *viâ* Ferozepur till through communication was restored; but by the exertions of the Railway staff they were safely taken over the break, or rather breaks, on Sunday night—the Mail Agent with them. The following telegrams have been placed at our disposal by the Railway authorities. *Monday*—'English mails got through, and will catch steamer which will be detained twenty-four hours. No mails will cross to-day. Expect to get mail service into order to-morrow; breaks said to be ready. We are just starting with loaded ballast train for the breaks.' *Later*—'Line from 200' (*i.e.*, two miles short of Barara) 'to 212,' (*i.e.*, six miles short of Jagadhri,) with difficulty passable by trollies and boats; from 200, for two miles, banks and bridges down.' Later information received by telegram from Umballa states that the Markunda bridge is safe, and has been crossed by the Engineers of the line. The worst break commences at mile 201, within sight of Barara. There is no prospect of getting traffic over for weeks, but the authorities hope to be able to get the mail letters over though not the banghis. It is proposed to send the out-going mails by road *dâk* to Jagadhri. It is further stated that several viaducts have gone; but the report is uncertain. Boats have been available; but are no use, as the water is too shallow and the ground swampy. It has been suggested by the Engineers on the spot that the Overland mails should leave a day earlier this week, and be sent *viâ* Ferozepur. In another telegram it is stated that there is a break on the line between Patiâla and Rajpur. Further and more detailed information has reached us concerning the breaks on the North-Western Railway between Saharanpur and Umballa. The part of the country in which the Railway has been damaged is peculiarly subject to inundation by sudden freshets from the hills; but in no previous instance was the rising of the water so

sudden as on this occasion. In fact, on Friday and Saturday last, the flood ran so quickly as to lead to the belief that some large body of water further up towards the hills had been suddenly released by the breaking of some *bund*. Not only has the Railway suffered, but there is every indication of a large loss of life and property throughout the district, which was for miles together completely submerged under about 8 to 10 feet of water. Luckily the floods went down as quickly as they rose; for had they continued twelve hours longer, the Engineers on the line consider that the whole Railway bank for about 12 or 13 miles would have entirely disappeared. The subsidence of the water has enabled a clearer idea to be gained of the damage done to the line. For about one-and-a-half miles, a little short of the station of Barara,—202 miles from Lahore,—the bank is practically wrecked. Throughout this length there are various gaps here and there, over which the rails are hanging in a succession of long loops. Quite close to the distant signal of Barara, one bridge of 10 spans of 10 feet each has been entirely washed out, and the girders lost. From half a mile short of Barara to 9½ miles beyond it, the damage to the line is insignificant; the only thing worth notice being that the mud buildings at the station of Mustaphabad have fallen. At 10 miles from Barara, the current of water across the line has scoured out a deep hole about 200 feet wide. The damage to the line practically, therefore, resolves itself into a mile-and-a-half of bank being carried away this side of Barara; and a large deep gap between Mustaphabad and Jagadhri. The first will be crossed by a diversion of the line with a temporary sleeper bridge, and the gap will be filled in. Both works are expected to be finished in about a week, so that through traffic may be expected to be re-opened about Wednesday or Thursday next (July 14th or 15th). Some difficulty is, however, experienced about labour, the people in the vicinity being too much engaged in saving the wreck of their own property, and looking after the safety of their own families, to find time to attend to the affairs of others. In the meantime a trolly service for the mails has been already started, the post bags being carried by elephants across the current, which is still running strongly at the site of the fallen bridge. It was at this point that one of the Native staff of the Railway unfortunately lost his life on Sunday last, being carried away by the torrent and drowned while trying to cross the mails. A trolly service for passengers will be running from to-day; but as some exposure is unavoidable, it would be as well for ladies, particularly if travelling with children, to defer their journey over this section of the line till the traffic arrangements are in a more settled state. The Markunda bridge, about which some fears have been current, is uninjured; although it is stated that the water rose very nearly to the top boom of the girders.

A correspondent who has gone down to the scene of the catastrophe writes :—'The breaks were caused through heavy rains in the low hills, which swept down over the flat country till bunded in by the Railway embankment, which is 6 to 7 feet high. The water rose to rail level, and then began its work of destruction, making channels for itself in the embankment, but leaving masses of earth here and there, which acted as pillars and supported the rails. The latter hang together by their fish plates and sleepers, rendering it possible but dangerous to run a trolly across: dangerous because in some places the rails were under water level. It took Mr. Mackinnon twelve hours to trolly the 15 miles on Sunday; but the subsidence of the water was so rapid that Mr. Mallet did the journey in four hours on Monday. The chief breaks are between Barara and Jagadhri; Mustaphabad and Kulchi stations, between the two, being completely washed away. Fortunately no bridges have been destroyed, excepting a small iron one of ten spans of 10 feet. The rainfall must have been abnormal, as this particular portion of the line has not been damaged for twenty years. There being no rivers, but only small streamlets, there is consequently no important drainage. The Markunda rose to the bottom of the bridge girders.—*Civil and Military Gazette.*

THE UMBALLA FLOODS.—Owing to the break in the Railway line between Jagadhri and Umballa, postal communication with Simla and Bombay, Bengal and the North-West, has been retarded and dislocated. Passengers have been obliged to incur great inconvenience and hardship, and the Railway staff of the North-Western System has been exposed to a long strenuous and exhausting effort, which has not up to the present time been crowned with success. It is not only the Railway that has suffered from the mad fury of swollen currents, but the Punjab Provincial Budget will have to meet an unexpected demand for repairs to a 6-arched bridge on the Grand Trunk Road which has imitated the example of the railway structures.

When the railway between Meerut and Amritsar was under construction, the Railway Engineers with their English experience were wont to laugh at what they called the excessive waterway provided by the great Engineers who preceded them for the Grand Trunk Road. The proximity of the road to the hills was not then a condition that was appreciated at its proper value. It was, however, not altogether lost sight of, and the controversy ran hot and strong as to whether the projected line from Delhi to Umballa was to adhere to the line of the Grand Trunk Road or to go *viâ* Meerut. The importance of connecting that military station with the military cantonment adjacent to the Native State of Patiála overcame the objections raised by some Engineers to crossing the line so close to the hills

over such rivers as the Jumna, Markunda and others. The subject of necessary waterway was carefully gone into, highest levels ascertained with all possible accuracy, and the various bridges were designed accordingly. The rainfall then was neither more nor less than at present. As many inches of rain used to fall between Simla and Mussoorie in 1866 as in 1886. Subject to slight annual variation, the elements for calculation were precisely similar in all respects except one. The time it took for a flood to run along its discharge course or river-bed was longer. A flood lasted longer than now; and the average quantity being then the same as now, it follows, if the floods last a less time, a greater volume of water, that is, a higher flood line and higher consequent velocity, must be the result. To that result must be attributed the failure of structures that were adequately designed 20 years ago; and the question arises: is the public to pay for the remodelling of bridges to render them adequate and suitable to these altered hydraulic exigencies—a process that has apparently no definite ending, or whether inquiry will be pushed into another direction? What is the root of this evil of many waters let loose on our road and railway embankments? The heavens have rained as hard before without causing this widespread damage. The cause is not far to seek, and inquiries must be addressed to the Forest Department. What is the condition of the forests stretching between, say, Simla and Mussoorie? Are they so clothed with trees and shrubs that the mountain flanks are a protection; is the rain retained or dispersed in infinitely numberless streams, garnered and treasured, and as it were filtered through zones of heavy obstacles? The words of the great French forester may be quoted appropriately. Surell says:—

"When trees attach themselves to the soil, their roots consolidate it and bind it with thousands of fibres. Their branches shelter it as it were a tent against the fury of the whirling rain. Their trunks, as also the fallen branches and twigs, the undergrowth and grass at their feet and that growth of weeds and other vegetation that surrounds them become so many various obstacles to small streams that otherwise would tend to unite. The total effect is to cover the soil, which *per se* is not immoveable with vegetable coating more capable of resisting erosive action of water. Besides, this vegetation divides and disperses currents over the whole surface of the soil which prevents them rushing and concentrating in mass along the watercourse lines."

But why harp on a subject that is patent to the meanest understanding? If hills, once clothed with forest, are denuded either by the axe, by fire, by injudicious grazing, or other causes, and they become bare, when our tropical showers burst upon them there is no dispersion, no absorption, no retardation—the raindrops slide over the smooth wetted surfaces of stone or uncovered soil, unite and pour headlong down into the main

currents filled to excess with a flood so incessantly and largely supplied direct from the clouds without intermediary and distributive vegetation ; and to this it is due that rivers are gorged, flood lines heighted and velocities so increased that all calculations are baffled, and in racing parlance all record is beaten.

Has this state of things been foreseen? Has the Forest Department brought forward these disastrous contingencies prominently before Government if unable to cope with the mischief itself? It is true that between Simla and Mussoorie (to designate by two well-known points a specific portion of the Himalayan ranges within which lies the drainage areas of the sinning rivers and the seat of the evil) there exists a considerable tract not directly under the Local Governments either of the Punjab or the North-Western Provinces. There are various Native States, the chief being the tributary State of Nahan, within whose territories the enactments and regulations of the Forest Department are null and void. Granted that our forest lines do not "run" within the areas where the mischief we complain of was born. What we want to know, what the public have a right to know is : what is the precise condition, from a forester's point of view, of the areas in foreign States that catch the waters the discharge of which through the railway bridges has this year cost the Indian Exchequer four to five lakhs over railway repairs, besides remissions of revenue to a considerable extent, much hardship and personal loss and suffering to riparian villagers within our own territory.

Sir, if the Bonerwals or the Waziris rush down from their mountain homes and raid our territory, carry away cattle and other plunder and fire our villages, unless ample compensation be made and the ring-leaders given up, as often as not Government is prepared to incur expenses perhaps a thousand-fold more than the property at stake in sending an expedition to chastise the offenders. Is Government in this instance going to do nothing but rebuild the bridges, and piously say it is the act of God and rest content, and with Turk-like credulity talk about *kismet?* If its Forest officers can point out the sore—can show on the map and by their reports that forest denudation has taken place—reckless felling been permitted and the once beneficent action of well-covered hills has been neutralised—then it is the duty of Government to arrest further mischief, to repair injuries already perpetrated, and insist on reboisement of the denuded areas. Surely, our Government is strong enough, and its duty clearly points to energetic action. Is a puppet Sikh Raja of Nahan or the insignificant feudatories that exist on sufferance, to be allowed, for the sake of immediate and present gains, to despoil forests that belong not to them but equally to the villagers on the plains. The inhabitants of the plains have every right to insist on the regulation of the hill forests. A source so pregnant with injury to them demands as much re-

gularisation by the hand of Government in public interests as these same interests on the Afghan Frontier postulate the expense and organisation of a strong military force against hill bandits. The same moral obligations apply. The greed and rapacity of petty hill magnates must be regulated. They cannot be permitted to allow for their personal benefit the destruction of protective forests. The consequent injury to crop and villages, and the serious menaces to the administration which prolonged breaks on a strategic and commercial line of railway present, utterly outweigh any consideration for personal interest being shown.

But primarily it is necessary for the Forest Department to show that owing to the destruction of such and such a forest certain floods were abnormally high. The public want to know has this been foreseen and Government warned about such a contingency? Has the Forest Department met obstacles: if so, how? Is it that District Officers take as usual too narrow a view of their duties, and, for the sake of the interests of one village, imperil the safety of others who are not perhaps within the District Officer's own particular territory? But it is just in cases like that where Lieutenant-Governors can make their *raison d'être* felt. Large public interests cannot be sacrificed to the supineness of any department, to the narrow-mindedness of District officials, or to the interests or prejudices of small Rajas.—SHAH-I-JANGAL.—*Pioneer.*

THE WOOD EXHIBITS AT THE COLONIAL EXHIBITION, SOUTH KENSINGTON.—*Canada.*—Prominent amongst the exhibits at South Kensington stands the timber produce of the various countries represented. Specimens of the forest growth of Canada, Australia, India, and the Cape are conspicuous in their natural state as well as sawn and polished, attracting the attention even of those who, from want of a more intimate knowledge, are unable to appreciate the important part they play in the world's history. We have heard visitors express their admiration of the beautifully polished surface of the fine log of Jarrah timber which adorns the Australian Court, and certainly they had reason, for a more splendid specimen of that durable tree could not have well been selected, and the way it has been prepared for display does credit to those who had the work to do.

It is not our purpose to discourse of the various woods in the order that they meet the eye of the visitor as he makes the range of the Exhibition, but to take them rather, one in each department, in the order of their utility, writing of those first which are in most common use. In this way our task will first embrace the woods from Canada, of which the different varieties, characteristic of the country, are artistically grouped in convenient places for inspection. It is the vulgar idea that the wooded portions of Canada form enormous tracts of dark, gloomy-look-

ing forests of pine, their sombre appearance unrelieved by any variety of tint. There never was a greater mistake made. The forests of Canada, on the contrary, are picturesque and pleasing to the eye, and in the season when the leaves begin to change the tints present many different shades and colours, lending to the woods an enchanting aspect, the same as a forest here would appear in autumn, somewhat enhanced by the majestic proportions of the trees in the Dominion.

As with us here, the pine tracts are peculiar to themselves, and whole sections of this useful tree and its near relation, the spruce, cover the hillside in dark belts, contrasting with the other varieties, forming a background which adds to the beauty of the Canadian scenery. The enormous size and straightness of the pine trees, of which these boundless fir forests are composed, we have very little experience of here. Trees of immense girth we undoubtedly possess, and our ancient oak and elms afford us specimens that often attain considerable altitude; but the huge stem of a Canadian pine of equal circumference, 80 or 90 feet without a leaf or branch, its lofty top crowned with the long and drooping fronds of needle-shaped leaves, is a sight seldom to be met with in the forest of the mother country.

There is not, of course, the same undergrowth in the timbered portion of the northern countries as there is in milder climes, but with this exception the difference in the appearance of the woods is not so marked. The forests of Canada are composed of pine, spruce, Scotch or Norway fir, oak, ash, elm, maple, birch, beech, larch, cherry, walnut, and other woods, and hardly a tree that we have named which does not come to our shores, though they do not always figure in the public sales.

Our readers are sufficiently acquainted with the merits of the white pine, or, as it is called over here, yellow pine, to need any description from us, but the various specimens supplied by Messrs. Burstall and Co. show of what a high finish it is capable in conjunction with its other preferential claims as an indispensable building material.

The chief of the timber districts, or, as they are termed "limits," of the Dominion, extend from the mountain shores of British Columbia, washed by the Pacific, containing immense forests, yielding some of the finest timber in the world, that are yet practically untouched, to the province of Ontario, the shores of Lakes Huron and Superior, the Georgian Bay country, embracing the Nipissing and Muskoka Rivers to the district drained by the Ottawa, St. Maurice, and Saguenay, to the province of Quebec and south shore of the St. Lawrence, and from the Saguenay to the Bersimis (both noted pine regions), and further on to St. John and the lower ports, where the mighty river empties itself into the Atlantic.

From this vast territory, thickly wooded with every species of timber, there is little fear of our supplies running short.

The inroads which have already been made are undoubtedly extensive to cause apprehensions of a failure in the cut of pine, but the question of forest exhaustion is still too remote to be seriously discussed at present. Many of the forests in the lake districts, Ontario and other provinces, are yet hardly touched, the land not being so suitable for agriculture, and from these regions sufficient pine will be drawn to make up for any deficiency that may be apprehended from the destruction of the older timber limits for many years to come. The importance of the forest supply of Canada to us here can hardly be estimated. Our annual consumption of pine and spruce is something marvellous, and it would be little short of a calamity if any failure took place in the forest resources of the Dominion.

We hear a good deal of the increasing scarcity of white pine, a tree which is said to be so valuable that it would be difficult to find a substitute for it were the Canadian forests to become exhausted. But this can hardly ever happen, if ordinary care is exercised to prevent destructive fires, as it will grow and flourish on the poorest soils, and is a rapid grower. Mr. Small, in his account of Canadian Forests, says that "intelligent lumberers consider that a white pine forest renews itself every twenty years." This must be an important consideration in estimating the forest wealth of Canada.

It seems that the wanton destruction of the forests in the province of Quebec was complained of by the French Governors of Canada as far back as 1696, that is 190 years ago, but the record says that "nothing was done by them to check it," and little has been done since. Is it not clear that Nature has again and again made good the ravages of man, and that still more pitiless enemy, the devouring element of fire, during the ages that have since intervened, and that she is still able to set the destroyers of her forests at defiance?

In addition to the thousand and one industries that cannot be carried on so well without the assistance of soft convertible timber, we have railways and railroads, which in the shape of sleepers, ties, platforms, stations, carriages, wagons, &c., add largely to the consumption of the forest produce.

The woods of British Columbia at the Exhibition are particularly noticeable, a large ornamental erection of pine from that country, supplied by the Hastings Saw-mill Company, Burrard's Inlet, being the first object that meets the gaze on entering the Canadian Court.

The woods from St. John were in a prominent position, a panel of each kind being scientifically arranged, the polished surface adorned with a neatly executed painting of the leaf.

We inspected the different specimens from New Brunswick, which include beech, ash, maple, birch, white and black hemlock, white pine, red pine, and balsam fir, as well as black and white spruce. Amongst the woods not generally shipped to this

country, but many of which, we think, could be used here with advantage, are the cherry, plum, bilbury, poplar, alder, hornbeam, butternut and willow, lime and basswood. Poplar is largely used in the States for a variety of purposes, and cherry is also in demand.

Ottawa, in addition to pine, is represented by neatly arranged specimens of sugar maple, red oak, figured beech, and from Burrard's Inlet, in addition to the pine specimens already mentioned, are some well-prepared blocks of red cedar and Oregon pine.

The specimens outside the court are sections of canoe, birch, tamarac, Ottawa best pine, Norway pine and red pine from Ontario, used as mining timber, the collection being sent by Mr. T. A. Keefor, of Port Arthur. There are several pieces of tamarac,* black larch, aspen, poplar, of very fine and smooth grain, another variety being the jack, or scrub pine. The suitability of many of these woods for use here depends on the cost. The home-grown woods, of which these would have to take the place, are plentiful, and, unless something were gained in size or price, their introduction would not be rewarded with success. A considerable objection to the softer kinds, such as poplar, tamarac, &c., is that they will not take the plane like the pine or deal, and in that respect present a marked contrast to the non-resinous woods of the north of Europe, all of which smoothen up equally to the red or yellow descriptions.

Tamarac or hacmatac ranks with our larch or juniper, and is the most durable of all the pine tribe. For shipbuilding purposes it is considered in the United States more durable even than oak, and it is well known and appreciated at Lloyd's in their classification of ships.

It is not to be expected that, within the limits of a single notice, we can describe, even superficially, the various objects of interest in the wood department alone ; and we have already occupied as much space as can be conveniently appropriated to the subject this week. What, therefore, has further to be said of this wonderful collection must be deferred to another number.—*Timber Trades Journal.*

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* The American Larch (?) (*Abies pendula*).

THE

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PRIZE DAY AT COOPER'S HILL COLLEGE.

AN interesting report of the prize day, on the 28th July last, at Cooper's Hill College, appeared in a recent number of the *Pioneer*, when we were very glad to see that Mr. Brandis was present. Sir Alexander Taylor, the President, in his address referred to the Royal Engineers and the Cooper's Hill men as furnishing the officers of the Public Works Department in India. He, however, omitted to mention Roorkee and the other Indian Engineering Colleges, which have turned out many very useful engineers.

The fact that, the Cooper's Hill College has this year furnished eleven officers for the Royal Engineers and Royal Artillery should assist in drawing together the men from Woolwich and Cooper's Hill.

Men for the Indian Forest Service are now being trained for the first time at Cooper's Hill, the instruction in forestry being afforded by Dr. Schlich, and the last set of men from Nancy have recently passed their final examinations with the French students, so that the long connection of the Indian Forest Department with the Nancy Forest School, which commenced in 1867, and has thus lasted for 20 years, has terminated.

Although French forestry is not always directly applicable in India, and some conservative members of the Indian Forest Department may still assert that foresters trained at Nancy should unlearn their French ideas, before they can be of practical use in this country, there can be no doubt that Indian forestry owes a great deal to France.

The magnificent oak and beech and silver fir forests of France have presented an ideal to which we endeavour to make our Indian forests approach, and though simpler systems of forest management may be more suitable than French ones for the Indian forests, yet the debt we owe to French foresters for the example they have given us in zeal for the well being of their forests, and to the *esprit de corps* of the French Forest Department, not forgetting their excellent Forest guards, can never be repaid.

Lord Kimberley referred to the forestry training at Cooper's Hill, and expressed a hope that the practical instruction in forestry might soon be given in India itself.

If such a course be decided on, and the men selected for the Indian Forest Department, after a preliminary training at Cooper's Hill, are sent to complete their course at the Dehra Dún Forest School, the latter will gain greatly in prestige and usefulness, and if besides this, a certain number of probationary Sub-Assistantships for the whole of India be thrown open annually by Government, for competition by students trained at the Dehra Dún School, the latter will then find its field of usefulness vastly increased, and the Forest Service of India will be efficiently recruited.

It is to be hoped that, in spite of a recent adverse decision of the Secretary of State, now that the Indian Public Works, Telegraph and Forest services are recruited together from Cooper's Hill, Government will raise the pensions for our Department to a level with those allotted to the others, and will insist on a compulsory contribution towards a common retiring and family pension fund, so that after having given the best part of our lives to the rough work, and frequently lonely life, of our Department, we may at least have a chance of spending the declining years of our lives in comfort, which the present full service pensions, varying from £300 to £400, at the now prevailing rate of exchange, will certainly fail to secure. Our Department has surely done nothing to deserve a lower status than the others, nor can Government wish that our controlling staff should be recruited by men who have failed to gain admission into the favored departments.

WORKING PLAN OF THE AKONA SAL FORESTS.

THE forests are of three different kinds—

1*st*,—High forest, though in very poor condition;

2*nd*,—Coppice, or rather badly pollarded forest;

3*rd*,—Fair coppice forest;

they are principally sál.

I have divided the forests into five working circles:—

		Acres.	
(1).	Pichwari—High forest, ...	2,602	
(2).	Bariar—Pollard and coppice, ...	3,657	12,664
(3).	Takia— „ „ „ ...	4,120	
(4).	Koano— „ „ „ ...	4,887	
(5).	Balapur—Fair coppice, ...	563	
	Total, ...	15,829	

About 25 square miles; of which 12,664 acres, or about 20 square miles, are very bad coppice.

The three forests comprising the 12,664 acres are pretty nearly of equal capacity, they are naturally divided into three portions, and are conveniently situated for supplying the different parts of the estate; thus the Bariar supplies the north-west, Takia the west and north-east, Koano the south and south-east; so that the people have not to go any extra distance for the produce they require. The forests too are, in a way, homogeneous, Bariar having larger trees than Takia, and Takia larger than Koano.

No. (1) will supply old mature timber for building, the branches and rubbish (as unsound centres) supplying fuel.

Nos. (2), (3) and (4) will supply fuel, house posts, rafters (though crooked) and stuff for miscellaneous use.

No. (5) will supply long ridge poles, dhanklies, and long straight poles.

Detailed working plans are attached.

In (1) I have taken a 65 years' rotation; the age of sál, 6 inches girth, being about 65 years, according to my calculations, but for safety's sake I have limited the cutting so that seedlings now on the ground will have 130 years to come to maturity, if that time be found actually necessary.

In (2), (3) and (4), I have taken the rotation as 30 years. This is about double the time that the present Rakhaona has taken to grow its present stock of coppice poles. There is no use in proposing a shorter rotation at present, as even the 30 years' rotation will not be able to be worked up to at first, at all events the present demand has not given hopes of it. Experience will be gained in the next few years. The past year or two's work has been interfered with by the people taking their dhankli poles, &c., at nominal rates from the unreserved forests. With a 30 years' rotation the amount of pollard stuff made available is $\frac{12664}{30}$ acres per annum, say 422 acres. But in time charcoal and poles will no doubt find a market at greater distances than they do at present: the railway will help to get a market, and arrangements should be made to get a market as long as even a trifle is made over and above working expenses, in order to get the forest into good order.

I expect a market will be easily found for the thinnings that will take place in No. (5); in another 6 years some of the forests now reserved will be giving in the strip fellings much better stuff than they yield now, and there is the Pipri forest still available.

The work was commenced in 1884, so that supposing the primary strips went over the forests in $\frac{1}{4}$ of 30 years, *i.e.*, in $7\frac{1}{2}$ years, the forests would be safely worked till 1891, when it would be advisable to inspect the forest and the work done, and see if the outturn might not be increased and the rotation shortened, in 7 years. I calculate the new strip growth will

have become as high as the present forest. My experiments in other parts of Oudh confirms me in this. By 1891 the soil will have vastly improved and the growth also. The quantity of material per acre will also be much greater than it is at present.

The Bálapur compartment will not be operated on till 1886, and will take 6 years, so that the first thinnings will not be completed till the end of 1891.

It is hoped that before the three and four periodic strips are operated on many straight young poles will have appeared, and some of them can be left as standards to increase the value of the forests.

If trees for seed be desired as standards, some of the present old trees, pruned so as not to give too much shade, can be left in the third and fourth periodic strips.

The working plan now proposed is one in which I have made safety the principal object next to the improvement of the whole forests. I have had to be cautious, as I believe this is the first working plan that has been made in India for sál coppice forests.

I also add a pattern "Record," which if properly kept should show at the end of any year how the working plan is being acted up to.

When the working plan was drawn up it was not quite settled what the width of the strips should be; they were cut $16\frac{1}{2}$ feet at first, and this width was decided to be adopted, but as the width of 33 feet might have been decided on, the areas worked over were in widths of $33' \times 4'$ (*see* strip system for coppice printed in the "Indian Forester" for September 1885). Thus $16\frac{1}{2}$ feet have been cut, and $132' - 16\frac{1}{2}' = 115\frac{1}{2}'$ left. The forest will be worked over in this way advantageously, as the thinning will be more gradual in succession of strips in compartments detailed as on the left hand Table, instead of as on the right.

	Strip System as modified for Akona.								
New Fourths.	Original Primaries.	" Tertiaries.	" Secondaries.	" Fourths.	New Primaries.	" Tertiaries.	" Secondaries.	" Fourths.	Original Primaries.
	16½'	16½'	16½'	16½	16½'	16½'	16½'	16½'	
	132 feet.								

	Wood's Regular Fourfold Strip System.				
Fourths.	Primaries.	Tertiaries.	Secondaries.	Fourths.	Primaries.
	16½'	16½'	16½'	16½	
	66 feet.				

Mr. Townsend, the officer in charge, has kindly marked on the

maps the actual work done, and has completed the records, which are sent instead of the pattern record. The strip system for sál coppice has been also commenced in Pilibhit, and the re-growth promises remarkably well. In some rich soil we have cut in strips 33 feet broad, leaving 33 feet of forest standing, the alternate strip system. In Akona the work is done by the fasli year, which answers better than the financial year.

E. WOOD, *Captain,*

BAHRAMGHAT, *6th April, 1885.* — *Conservator of Forests, N.-W. Provinces and Oudh, Oudh Circle.*

Pichwari Working Circle (High Forest), No. 1. (Fig. 1).

No.	Names of Compartments.	Areas in Acres.
I.	Itaunjah, ...	671
II.	Bhagwanpur, ...	448
III.	Baraipur, ...	324
IV.	Jamnaha, ...	554
V.	Salwariah, ...	605
		Total, 2,602

Proposed rotation 65 years $= \frac{2602}{65} = 40$ acres per annum.

The strips are to be 33 feet broad (with 231 feet between the strips), therefore each mile of strip = 4 acres: this gives 10 miles of strip per annum. But till the growth be better known, and the soil is more improved for the growth of seedlings, only 5 miles of strip should be cut in any one year without reference to the Conservator.

Fellings should take place in the Itaunjah compartment, and commence 404 feet east of the junction A of the Salarpur-dih-Bhagwanpur traffic line BC and the Akona-Tandwah Mahaut line DE, and should run at right angles to the latter line.

Working eastwards, everything on the 33 feet strip should be cut flush with the ground, and the material taken out immediately, either north or south, along the strip.

The fellings should only take place between the 1st of November and the end of February, and no new strip should be cut till the material on the previous cut line has been arranged for and disposed of.

The Circle should be protected from fire and grazing.

Bariar Working Circle (Coppice), No. 2. (Fig. 2).

Order of working.	Names of Compartments.	Sub-Compartment.		Area in Acres. Tree Forest.
I.	Alinagar, ..	..	..	612
II.	Barhaipurua, ..	(a) Barhaipurua,	395	
		(b) Baxaria, ..	175	570
III.	Thakurjot, ..	..	..	860
IV.	Samgarha, ..	(a) West, ..	502	
		(b) East, ..	445	975
V.	Rampur, ..	..	..	640
				Total, 3,657

Proposed rotation 30 years.

Area to be cut annually $\frac{3657}{30} = 120$ acres $=$ 60 miles of strip $16\frac{1}{2}$ feet broad.

Except in compartment II., lines of export to run due north and south, as shown by dotted lines. The work, except in compartment II., always to commence on the west of the export lines, and proceed from north to south, no new work being commenced till the whole work on one side of the export line is completed. Here the export lines will be the directing lines.

The work should be done between the 1st of November and 15th March; no more material should be cut than can be disposed of.

The strips are to be $16\frac{1}{2}$ feet broad, with $115\frac{1}{2}$ feet between the strips.

The whole Circle should be protected from fires and grazing.

The cut produce should be removed before 15th March from off the strips.

Takia Working Circle (Coppice), No. 3. (Fig. 3).

Order of working.	Names of Compartments.	Sub-Compartment.		Area in Acres, Tree Forest.
I.	Iokaha-Mangarh, ..	..	..	824
II.	Dinnamgarh, ..	..	..	1,487
III.	Bhawanipur, bank at East,	..	..	902
IV.	Bhawanipur, bank at West,	..	..	580
V.	Majhaoan, bank at, ..	..	..	327
				Total, 4,120

Proposed rotation 30 years.

Area to cut annually $\frac{4120}{30} = 138$ acres $= 69$ miles of strip $16\frac{1}{2}$ feet broad.

I. Work commences west of middle line CD, working from south to north, then east of CD working from north to south.

II. Run three lines at right angles to I. and II. division line from points A, H and K; run strips at right angles to these lines working from south to north.

III. Take III. and I. division line (EF) as directing line, and run at right angles to EF, commencing at E, and working from north-west to south-east.

IV. Take III. and IV. division line as directing line, and run strips to the west working from south to north.

V. Take north-east boundary line (BG) as directing line, and run strips at right angles to it, commencing at *north-west corner (B) and working east.*

The work should be done between 1st November and 15th March; only as much as can be sold should be cut, and the cut produce should be removed before the 15th of March from off the strips.

The strips are to be $16\frac{1}{2}$ feet broad, with $115\frac{1}{2}$ feet between the strips.

All the Circle should be protected from fire and grazing.

Koano Working Circle (Coppice), No. 4. (Fig. 4).

Order of working.	Names of Compartments.	Sub-Compartment.		Areas in Acres, Tree Forest.
I.	Sheopur, bank at, ...	(*a*) West ($a+a'$)	530	
		(*b*) East, ...	610	1,140
II.	Narpatpur, ...	(*b*) East, ...	375	
		(*a*) West, ...	430	805
III.	Misrowleah, ...	...	...	1,302
IV.	Towrdih, ...	...	...	650
V.	Ramwapur, ...	...	...	990
				Total, 4,887

Proposed rotation 30 years.

Area to be cut annually $\frac{4887}{30} = 162$ acres $= 81$ miles of $16\frac{1}{2}$ feet strips.

I*a*. Strips to run from line *cd* west, parallel to *cf*, and working from north to south.

I*a'*. Strips to run from line *cd* east, at right angles to *cd*, and working from north to south.

I*b*. Strips to run from line *ce* east, parallel to *cg*, and working from north to south.

II*b*. Strips to run at right angles to *fh*, and working from west to east.

II*a*. Strips to run at right angles to *mo*, first to east from north to south, and then to west from south to north.

III. Strips to run parallel to *gk* running east, and working from north to south.

IV. Strips to run at right angles to *lk*, commencing at *l*, and working from east to west.

V. Strips to run at right angles to *kl*, commencing at *k*, and working from west to east.

The strips to be 16½ feet broad, with 115½ feet between them.

Work to take place between 1st November and 15th March: only as much should be cut as can be disposed of and removed before 15th March from the strips.

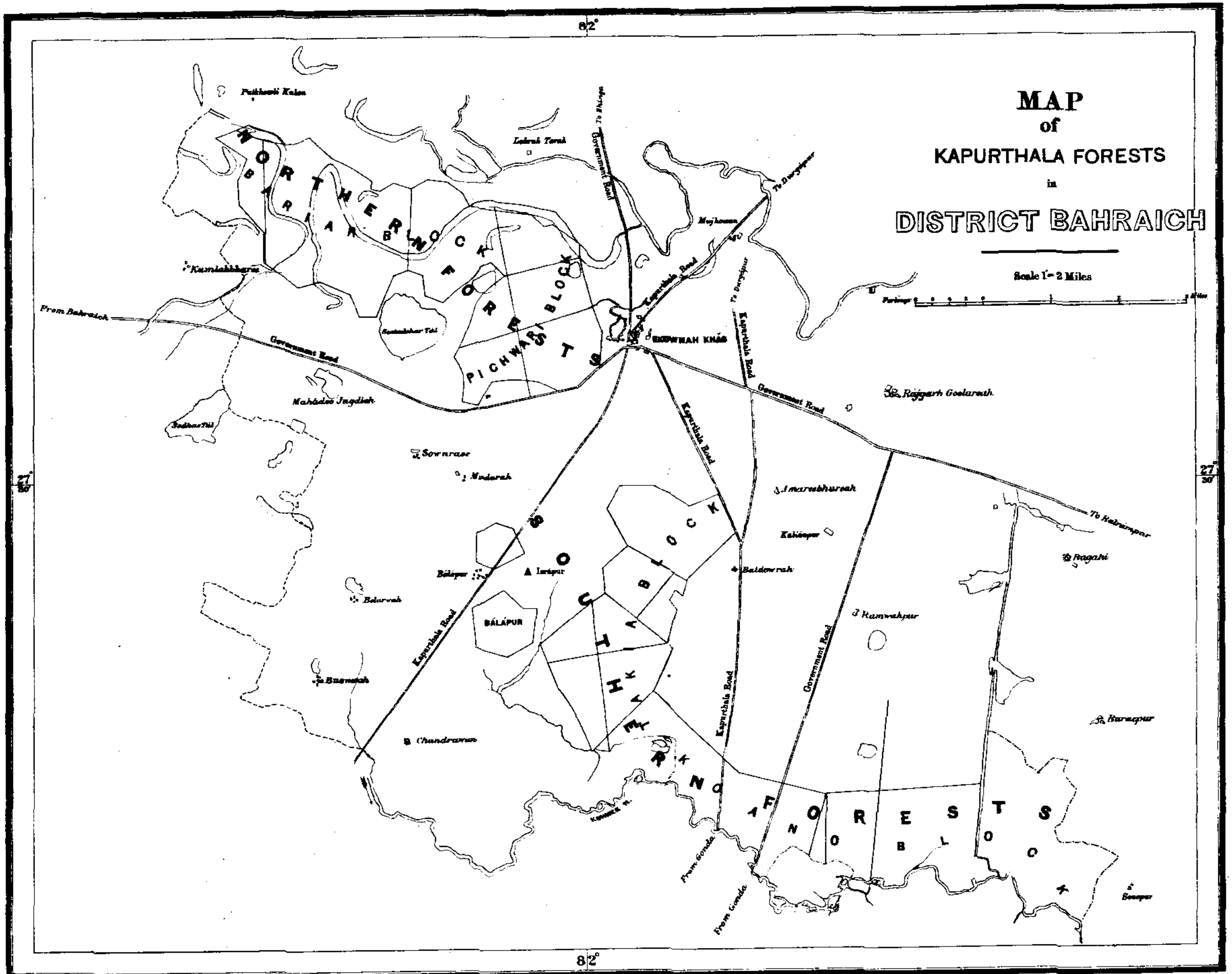
The whole forest should be protected from fires and cattle.

Balapur Working Circle (Coppice), No. 5. (Fig. 5).

Order of working.	Names of Compartments.		Sub-Compartment.		Areas in Acres, Tree Forest.
I.	Balapur Rakhaona,	...	...	...	361
II.	Pipri, ...	...	...	...	202
					Total, 563

Note.—There must be some error in Mr. Townsend's note, or *the Rakhaona has some grass patches which are not taken in* the area. I have a note in which Mr. Townsend has given me the area of the Rakhaona as 361 acres, and I will work on this. It is proposed not to work Pipri in the first period of 7½ years, nor till the Rakhaona has been completed: in the meanwhile it, as well as the Rakhaona, should be protected from cattle and fires.

The growth in the Rakhaona is different from that in the three other coppice working circles. Here the stems are principally straight, though there are often too many shoots on one stool. The operation will be pruning and thinning and not a clear felling.

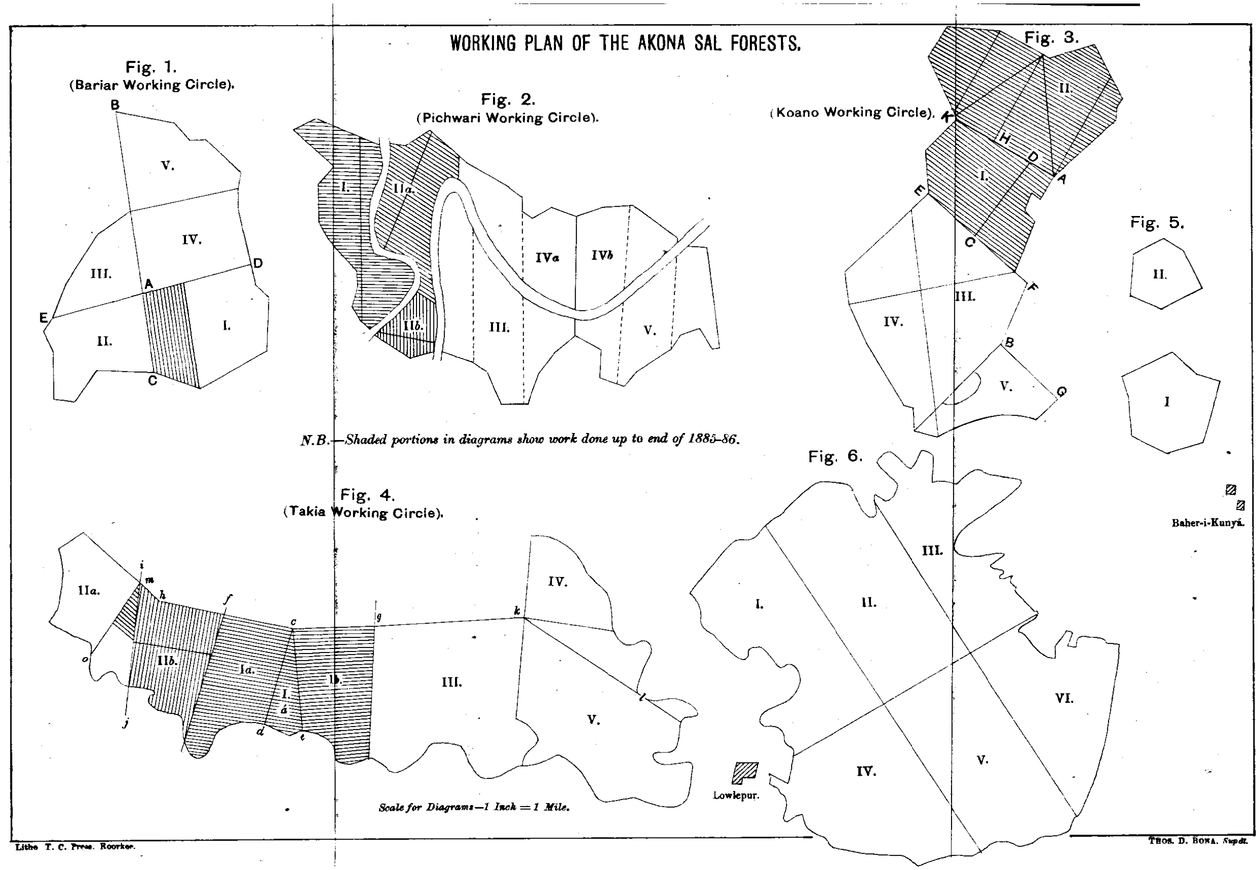


Sibba Ram, Photo.

C. G. Ollenbach, Zinco.

Copied in the Forest Survey office, by Narayan Dás, from the 1" Oudh Revenue Survey maps, and information supplied by Conservator of Forests Oudh Circle N.W.P.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, September 1886


WORKING PLAN OF THE AKONA SAL FORESTS.
Fig. 1.
(Bariar Working Circle).
Fig. 2.
(Pichwari Working Circle).
(Koano Working Circle).
Fig. 3.
Fig. 5.
N.B.—Shaded portions in diagrams show work done up to end of 1885–86.
Fig. 4.
(Takia Working Circle).
Fig. 6.
Baher-i-Kunyá.
Lowlepur.
Scale for Diagrams—1 Inch = 1 Mile.
Litho T. C. Press. Roorkee.
Thos. D. Bona, Supdt.

The working plan of the Rakhaona, with drawing to a larger scale, is given below.

Balapur Working Circle. Balapur Rakhaona Compartment.
(*Fig.* 6).

In the cold weather of 1885-86 the 8 feet line from the villages shown should be made, then the one to the south-east, and then the one to the north-east.

The sub-compartments should be worked as below :—

Order of working.
I. in 1886.
II. in 1887.
III. in 1888.
IV. in 1889.
V. in 1890.
VI. in 1891.

Any suppressed trees should be removed.

Where more than two stems start from one stool, any number over two may be removed, always leaving the two straightest and longest. The work may take more than 6 years, but should not take less. The work should always commence from the centre line running from village to village and work outwards to the edge of the forest, leaving off as much as possible in a line parallel to the central line.

The work should take place between the 1st of November and 15th March, and all cut stuff should be removed out of the sub-compartment before the latter date.

No cut stuff should be moved through a sub-compartment that has been operated on.

The shoots when large should be sawn off with as near a vertical cut as possible, and the stump should afterwards be trimmed with an axe and present a smooth surface, so as not to let the rain lodge and affect the stool.

No more should be cut than what is certain to be sold or disposed of.

Pruning and Thinning.

Area 361 acres.

Proposed period of 1st thinnings 6 years $\frac{361}{6}$ area to be operated on, about 60 acres a year. About 60 acres each in the areas of the sub-compartments.

The line fellings should be disposed of before commencing operations in sub-compartment I.

Record of Working Plan. Akona Forests (years 1884-85 and 1885-86).

Strip Fellings. Working Circle No. 1 (Pichwari) $\frac{\text{Area } 2602}{\text{Rotation } 65 \text{ years}}$ = 40 acres per annum = 10 miles of 33 feet strips a year.

(But until further orders from the Conservator, 5 miles only to be cut annually).

Year. A. C.	Year. Fasli.	Description of strips.	Breadth of strips.	Compartment.	Sub-compartment.	No. of strips cut.	Length of strips cut.	Acres cut.	Acres up to date, actuals.	Acres to be cut up to date according to working plan.	Actuals less than working plan directions.	Actual excess over working plan directions.	Remarks.
			Feet.				M. Fur. Ft.				Acres	Acres	
1884-85	1292	Original Primaries,	33	I.	...	8	6 5 220	$26\frac{2}{3}$	$26\frac{2}{3}$	40	$13\frac{1}{3}$	...	Strips running S. Working W. to E. starting 404 feet E. of Bhagwanpur. Salardeh line, measuring from cross roads at N.-W. corner of compartment.
1885-86	1293	...	...	I.	...	...	...	...	$26\frac{2}{3}$	80	$53\frac{1}{3}$	...	A blank year in consequence of Mr. Townsend's absence on leave.

Record of Working Plan. Akona Forests (years 1884-85 and 1885-86).

Strip Fellings. Working Circle No. 2 (Bariar) $\frac{\text{Area } 3657}{\text{Rotation } 30 \text{ years}} = 120$ acres per annum = 60 miles of $16\frac{1}{2}$ feet strips a year.

Year. A. C.	Year. Fasli.	Description of strips.	Breadth of strips.	Compartment.	Sub-compartment.	No. of strips cut.	Length of strips cut. M.	Length of strips cut. Fur.	Length of strips cut. Ft.	Acres cut.	Acres up to date, actuals.	Acres to be cut up to date according to working plan.	Actuals less than working plan directions.	Actual excess over working plan directions.	Remarks.
			Feet.										Acres	Acres	
1884-85	1292	Original Primaries,	$16\frac{1}{2}$	I.	...	138	32	1	286	$64\frac{1}{3}$	...	...	...	...	Strips running E. and W. of direction line. Working N. to S. Completed original primaries.
...	...	...	...	II.	*a*	39	9	1	165	$18\frac{1}{3}$	...	...	...	..	Strips running N.-W. and S.-E. Working from N.-E. to S.-W. *Left* at 18 on W. and 21 E. of base line.
...	...	...	...	...	*b*	34	7	5	440	$15\frac{1}{2}$	...	...	...	...	Strips running N. to S. Working W. to E. Completed original primary strips.
...	...	...	...	...	...	...		...		$98\frac{1}{6}$	$98\frac{1}{6}$	120	$21\frac{5}{6}$	...	
1885-86	1293	Original Primaries,	$16\frac{1}{2}$	II.	*a*	51	14	4	495	$29\frac{1}{4}$	$127\frac{1}{3}$	240	$112\frac{1}{2}$	...	Completed original primary strips.

Record of Working Plan. Akona Forests (years 1884-85 and 1885-86).

Strip Fellings. Working Circle No. 3 (Takia) $\frac{\text{Area } 4120}{\text{Rotation } 30 \text{ years}} = 138$ acres per annum $= 69$ miles of $16\frac{1}{2}$ feet strips a year.

Year. A. C.	Year. Fasli.	Description of strips.	Breadth of strips.	Compartment.	Sub-compartment.	No. of strips cut.	Length of strips cut. M.	Length of strips cut. Fur.	Length of strips cut. Ft.	Acres cut.	Acres up to date, actuals.	Acres to be cut up to date according to working plan.	Actuals less than working plan directions.	Actual excess over working plan directions.	Remarks.
			Feet.										Acres	Acres	
1884-85	1292	Original Primaries,	$16\frac{1}{2}$	I.	...	66	33	5	454	$67\frac{3}{8}$	...	...	...	...	Strips running E. and W. of base line. Working N. to S. Original primary strips completed.
...	...	...	...	II.	...	30	19	4	176	$39\frac{1}{12}$	...	...	...	...	Strips running E. and W. of base line. Working N. to S. Left off at 15 on either side of base line.
...	...	...	...	...	...	...		...		$106\frac{1}{2}$	$106\frac{1}{2}$	138	$31\frac{1}{2}$	...	
1885-86	1293	Original Primaries,	$16\frac{1}{2}$	II.	...	57	41	0	0	82	$188\frac{1}{2}$	276	$87\frac{1}{2}$	...	Completed original primary strips.

Record of Working Plan. Akona Forests (years 1884-85 and 1885-86).

Strip Fellings. Working Circle No. 4 (Koano) $\frac{\text{Area } 4887}{\text{Rotation } 30 \text{ years}} = 162$ *acres per annum* $= 81$ *miles of* $16\frac{1}{2}$ *feet strips a year.*

Year. A. C.	Year. Fasli.	Description of strips.	Breadth of strips.	Compartment.	Sub-compartment.	No. of strips cut.	Length of strips cut. M.	Length of strips cut. Fur.	Length of strips cut. Ft.	Acres cut.	Acres up to date, actuals.	Acres to be cut up to date according to working plan.	Actuals less than working plan directions.	Actual excess over working plan directions.	Remarks.
			Feet.				M.	Fur.	Ft.				Acres	Acres	
1884-85	1292	Original Primaries,	$16\frac{1}{2}$	I.	a & a'	73	33	3	0	$66\frac{3}{4}$	$66\frac{3}{4}$	162	$95\frac{1}{4}$	...	Strips running E. and W. of base line. Working N. to S. Left off at strip 39 W. of base line.
1885-86	1293	Original Primaries,	$16\frac{1}{2}$	I.	a	16	4	1	40	$8\frac{1}{4}$	...	...	...	...	Completed original primary strips.
...	...	...	...	...	b	52	26	5	99	$53\frac{1}{4}$	...	...	...	...	Strips running E. Working N. to S. Completed original primary strips.
...	...	...	...	II.	b	49	16	6	0	$33\frac{1}{2}$	...	...	...	...	Strips running N. and S. Working E. *to* W. Completed primary strips.
...	...	...	...	II.	a	12	1	3	275	$2\frac{3}{4}$	...	...	...	...	Strips running E. only. Working N. to S. Left off at strip No. 12.
...	...	...	...	...	...	...		...		$97\frac{3}{4}$	$164\frac{1}{2}$	324	$159\frac{1}{2}$	...	

THE FOREST SCHOOL AT DEHRA DUN.

From an outsider, and a somewhat distant one, a few remarks on the work of this institution as described in the Director's Report of the 5th course, may perhaps be acceptable to those of the readers of the "Indian Forester" as have not seen the original report, and the admirable accompanying memorandum by the Officiating Inspector General of Forests.

To quote Mr. Ribbentrop's remarks, the instruction is divided into two courses, that for Rangers, in which the instruction is given in English, and that for Foresters, in which Hindustani is used. The former course was one of 18 months, *viz.* :—

Junior Class, July 1st to December 31st, 1884,
Senior „ January „ „ „ 1885,

but in addition, a further 3 months of practical work was given, making 21 months in all. The Junior Class learnt Physics, Chemistry, Physiological Botany, Road-making, Plan Drawing and Mathematics ; and spent the last two months in practical Surveying under the Superintendent of Forest Surveys. The Senior Class spent one month in completing the practical Surveying, and then studied Forestry, Geology and Mineralogy, Forest Law, Forest Protection, Mathematics, Systematic and Geographical Botany. For the Forester's course, Elementary Physics, Mathematics, Forestry and its allies, Botany and Physiography, Surveying and Plan Drawing. In all cases the lectures occupied 30 hours a week, the hours of lectures being 7 to 10 A.M. and 12 to 3 P.M.

The Senior Class of the Ranger's course spent 8 months of their 12 in the field—while on tour they were first of all, and most necessarily, taught to recognize the principal trees and shrubs met with, and to understand the chief noteworthy facts regarding them. Then they proceeded to Sylviculture proper, and were taught to understand the laws which regulate the growth and maintenance of forest crops and the habits of the component trees on which management is based. Then came the practical work of forest operations, such as thinnings for coppice, and cuttings for seed regeneration ; succeeded by the works necessary for the felling, conversion and transport of timber ; as well as the formation of nurseries and systems of artificial reproduction. All this part of the course was given in the field, so that the students were able actually to see the various works carried on and themselves to assist in them. On their return to Dehra the second theoretical course began, and comprised a very wide range of subjects connected with Forestry in general, ending up with the elements of working plan making. If anything, the range may be said to have been too wide, for in the writer's opinion a firmer grounding in the elementary portions and more actual practical work would be more likely to fix itself in their minds. It must be remembered that some of

the students, at any rate, on return to their provinces may be posted to divisions, where there is little more to be done than to control the issue and recovery of permits, or to measure up timber on a river; and much of the more elaborate teaching they have had may be likely to be forgotten before they obtain a charge in which they can apply it. Were we better supplied with text-books, the writer would advocate a very short theoretical course succeeding a long practical one, for the ground-work thus laid could be built upon by private study; but at present text-books are scarce, and what there are, are too abstruse for the Ranger's class, so that after all there is a probability that those in power at the Forest School are right in the end, and that the remarks made by Mr. Ribbentrop in clause 2 of paragraph 6 of his memorandum correctly appreciate the position—

> "The progress which has again taken place in the development of the Forest School in every direction is remarkable and satisfactory, from many points of view; but the danger of teaching above the head of the average student at present available is not entirely absent, and must not be lost sight of. The requisite standard of education amongst the candidates for the Ranger's Class admitted to the Forest School is no doubt to a certain extent ensured by the demand of a certificate of having passed the University Entrance Examination on the English side; but, as a matter of fact, the relative knowledge, especially with regard to English and Mathematics, varies to a very considerable extent, and it becomes necessary that the teaching should be adapted to the understanding of the average student, rather than to the faculties of the cleverer and more advanced candidates."

Speaking from some experience, however, the writer would say that where our Rangers mostly fail is in the correct appreciation of facts of Sylviculture, and the experience which leads them to decide at once what to do in a forest operation.

On return from their course, they are probably able to talk and write glibly enough about the things they have heard in the lectures, but as probably fail when set down to apply them in the field. The suggestion may be made that a portion of the junior course, as well as of the senior, should be devoted to making the students familiar with forest operations of a professional character, and that more in the plains forests than in the hills, among the sál rather than among the deodar.

So much for the 'Forestry' teaching. It was supplemented by instruction in Systematic Botany, mainly in learning how to use the 'Forest Flora' so as to be able to make out the trees and shrubs met with. This is quite as it should be; but it might be suggested that, which is not mentioned in the Report, the use of the dissecting microscope, indispensable for small living and for almost all dried plants, might be added with advantage. Geology and Elementary Mineralogy, including the rough analysis of soils, were also taught. The Law course included—(i), General Law of property, possession, servitudes, &c.; (ii),

Forest Law, and (iii), Criminal Law, both General and Forest. The Mathematics embraced chiefly Trigonometry and Elementary Statics, while to it were added Plan Drawing and Surveying, the work of the Junior Class* being necessarily more elementary.

Thus it will be seen that a fairly intelligent student, who obtains the Ranger's certificate, should be competent to carry out most forest operations, to make thinnings, cuttings and valuations; to survey his forests, divide them into blocks and compartments for working, to fell, log and transport timber, and prosecute offenders. We would suggest, however, that a little more acquaintance with the preparation of estimates, and especially those for forest roads and small forest houses, such as are required by the Forest Codes, would be an advantage. But as it is, a passed candidate should be, under actual circumstances, capable of carrying out the work of a large range or sub-division, and eventually becoming a Sub-Assistant Conservator. It is important that such men should, wherever possible, be employed in those Divisions in which professional work is going on, leaving those of a routine character to their untrained fellow Rangers.

The work of the Vernacular Class seems to have been very thorough, especially in the very important subjects of Physical Geography, Physics and Elementary Chemistry.

The students who followed the course came from various provinces, North-Western Provinces 16, Madras and Punjab 11 each, Bengal 4, Coorg, Central Provinces and Burma 2 each, and Ajmere 1; while 10 were sent by the Native States of Mysore, Baroda, Patiála and Jeypore, and 4 were private students. There were none from Bombay, which is a pity, for the School at Poona can scarcely boast such a teaching staff and such appliances as can be found at Dehra.

The results were that, 9 of the students obtained the Ranger's certificate and 3 that of Foresters—and if, as may be hoped, the number of students should gradually increase—every succeeding year will see a great addition to the number of Forest subordinates capable of understanding professional work, and a vast change for the better in the work of the Department, which outsiders are frequently apt to sneer at as being 'work that any body can do.'

It is greatly to be hoped that in time this successful institution may be able to go a step further, and not only carry out the suggestion of the acting Director that young officers from Cooper's Hill might with advantage learn their language, their law and the preliminaries of their work at Dehra; but even

* During the Junior course, two months (November and December) are devoted to Surveying in the field, and the remaining months (July to October) are spent in Dehra in Plan Drawing and in the study of Physics, Chemistry, Mathematics and the anatomy and physiology of plants, which necessarily precede Sylviculture.—[ED.]

pass one of their years of instruction at that institution. There is probably neither in England nor in any British Colony, a better staff of English professional Foresters than there is at Dehra, and the instructors there should be able to instruct embryo Assistant Conservators as well as they can embryo Rangers. In conclusion, the last paragraph of Mr. Fisher's report is worthy of reproduction—

"It is evident, however, that the main object of the Dehra Dun Forest School is to train Rangers, and it is hoped that, now that well educated young men are coming forward for these appointments, the proper status of Forest Rangers may be recognized by Civil Officers, and that they may be ranked, by the authority of the Government of India, in the same position, and be treated with the same consideration, as Inspectors of Police and other public officers drawing similar pay to their own. This is far from being the case at present, and the absence of such consideration is a substantial grievance and hinders our obtaining better men for the Forest Department, the steady improvement in the revenues of which depends principally on the exertions of the men in charge of ranges."

NOTE ON BAMBOOS.*

BAMBOOS may be propagated either by planting out sets from existing clumps, or by sowing seed. If sets are used they should be taken from vigorous two or three year old shoots with their rhizomes, and transferred with soil about the roots to the pit in which the bamboo is to grow. The stem should be cut back above a joint at about 5 feet, and the set planted about 8 or 10 inches deep in the early rains, and as quickly as possible after removal from the parent clump. The new shoots will then be thrown up from the eyes, and, all things being favourable, bamboos fit for sale will be produced on good soil in about six or seven years. The stem may be removed and the set laid flat under the soil, as is done with sugarcane sets. This method has given good results, but the sets were regularly watered from a well.

If seed is used, it should be put down in worked earth, just below the surface, and should be lightly watered. It will throw up a shoot like grass, from the eyes of which new shoots will be thrown up during the first year. In the second year, other and larger shoots will be thrown up, and so on, each year's shoots being larger in girth and taller than those of the preceding year until the full size of the culm of the kind of bamboo is attain-

* The above is taken from a very readable little pamphlet by Colonel van Someren, Conservator of Forests, Berar, and obtainable from Messrs. Thacker and Co., Bombay. It consists of papers on Indian Forestry originally published in the "Indian Agriculturist" for 1884, intended by the author to answer, in a popular manner, the question "What do you Forest officers do?"—[ED].

ed. With sufficent rainfall, and in a good but not too moist a soil, bamboos fit for sale may be cut in from about seven to ten years. On poor dry land, or on sandy soils, the period may extend to twelve years or more. The seed used should be not more than a year old, and should be sown very sparsely in the bed.

The first shoot that comes up from a seed never grows into a bamboo. As already explained, the eyes throw up shoots which develope into stems. Each stem comes up as large in girth as it ever will be. It first appears as a scaly cone covered with sheaths. It then rapidly attains its full height, when the leaf sheaths at its nodes either diminish in size or gradually fall off and give place to leaves; the stem branches on its upper half, and on completion of the branching is matured. It does not grow any taller or stouter, nor does it solidify or fill up inside year by year, but stands in the clump till it dries off and dies in from twelve to fifteen years. Each stem matures under ordinary circumstances in about twelve months. A clump of bamboos of, say, twelve years of age is thus a collection of stems from one to twelve years of age and of different sizes, the variety of size being caused not by the annual increase of the older stems, or of any individual stem, but by the fact that each annual crop of shoots produces stems of greater diameter and height than those of the preceding year until the limit of the normal size of the species in both height and girth is reached. That limit may be reached in very favourable circumstances in five years, a shoot of that year coming up, perhaps, two or more inches in diameter in the first heavy rains, and rising by October to 40 or 50 feet in height. The new shoot not being branched at first is able to make its way through its companions, and, as already said, it begins branching on attaining its full height.

All that has been now written of the manner of growth applies equally to stems produced from sets or from seed. But a clump produced from seed has its normal period of life before it, whereas a clump from a set has before it only that portion of life period which had not been already spent by the parent clump from which the set was taken.

The life of an individual stem is by no means the same as that of the clump to which it belongs. Individual stems die off in from ten to fifteen years, while the common life of the clump may extend over from twenty to forty or fifty years. Some species are shorter lived than others, and the duration of the longer lived species is not accurately known, but fifty years is probably the extreme. Individual stems thus dry up and die in succession without seeding, but the clump lives out its normal period, when it flowers, seeds, and dies; all stems then living, whatever their age or size, seeding and dying together.

As each stem matures separately, and, once matured, will

never become any larger, it may be thought that when a clump has attained sufficient age to produce stems fit for sale, such culms might at once be cut out and utilized. But this would stop the increase of the clump, for it is only the young stems that are less than four years old that send up fresh shoots from their rhizomes. It thus follows that the younger stems should be left till at least their fifth year, while the older stems may be removed, for they are matured are no longer reproducing themselves and are saleable.

This peculiarity of the bamboo makes it a matter of some little difficulty to decide whether a block of bamboos is, or is not, being overworked. The condition of the separate clumps, or of a large proportion of them, must be studied, and measures must be adopted, and enforced, to prevent the reproducing stems being cut out. They are often among the finest in the clump, and often also the handiest to the axe of the cutter. They must be preserved, while if too many old stems are left, the young shoots will be hampered in their growth and become much twisted in their lower portions. Owing again to this peculiarity the closing of blocks of bamboo forest against cutters for a term of years may indeed protect the newer culms, but will also lead to many of the older ones being wasted. Each case must be settled on its own merits, but where good supervision can be enforced the closing of blocks is not advisable.

In Bengal, in parts of the North-West Provinces, in the Deccan, in Mysore and Madras, and possibly elsewhere in India, it is an article of common belief among natives and acted up to in practice, that bamboos cut in the bright half* of the month are sure to be attacked by insects and to turn quickly to powder; while those felled in the dark half of the moon's course will last for a long time. It is also held that the new shoots are not sent up, even if rain falls, till the thunderstorms that precede the monsoon have set in; and, further, that the more the thunder, the larger will be the number of new shoots sent up that year.

COST OF FIRE CONSERVANCY IN BURMA.

THE following note has been drawn up with a view of explaining to a slight extent the high cost of fire conservancy in the Pegu Circle, and it is hoped some officer from Berar and from the Central Provinces will favour the "Forester." with information explaining the low cost of similar work in those Provinces.

* An experiment to decide this, was carried out at Dehra in 1884, and the popular theory was fully confirmed, the 100 bamboos cut in the bright moon being riddled by insect borings, whilst the 100 cut in the dark half of the month are almost untouched. It is probable that, the insects which cause the borings only deposit eggs on bright nights.—[ED].

To permit of a fair comparison of the cost of fire protection in the different provinces, the following are some of the factors which must be taken into consideration:—

(*a*). Number and area of the different tracts.
(*b*). Physical aspect of these.
(*c*). Their position with regard to villages, cultivation, rights of way through them, &c.
(*d*). Method of protection (including length and width of fire paths cleared).
(*e*). Nature of vegetation cleared.
(*f*). Cost of labour.
(*g*). Duration of hot season.
(*h*). Number of officers solely available for this particular work.

With regard to (*a*) it is clear that a number of isolated small tracts, which have to be fire-traced and watched, will cost more than one block containing the same area; the length of outer fire paths is greater and more watchers are necessary. This is borne out by your Review (compare Bamoni Hill in Assam and the Gugamal reserve in Berar).

The physical aspect of the country affects the cost in as far as over steep ridges and broken ground the paths must be wider, the process of clearing the paths is slower, and the cost consequently greater.

Tracts distant from villages are affected; there is the difficulty of obtaining labour and providing food as well as enhanced daily rates. On the other hand, forests surrounded by villages or cultivation, and traversed by numerous rights-of-way, are, in Burma, of which province I am writing, liable to be fired by travellers, hunters, cartmen, &c., hence an increased number of watchers is necessary.

As for the method of protection where the boundary of the forest is formed chiefly by a broad running stream, evergreen jungle or a precipitous ridge, over which fire cannot cross, the cost is nil, and although perhaps in a few places a little clearing or watching may be necessary; divided over the whole area, the cost of this work is reduced to a trifle.

The nature of the vegetation cleared must be considered, a line cut through bamboo or scrub jungle costs considerably more than one running through low grass or high tree forest. The cost of labour and duration of the hot season are very important factors, and it is quite certain where one officer can be deputed solely to look after the fire protection of one tract, the work will be carried out cheaper and better than if he has to supervise fire-tracing of three or four, and in addition carry out girdling, collect revenue, mark contractor's timber, &c., as is the case in the Pegu Circle.

I have not the time to furnish a detailed description of the measures adopted for the fire-protection of the different tracts

in the Pegu Circle. In all there are 20 distinct blocks, scattered over the different divisions, four of these are under 100 acres in extent and consist of plantations. The work of clearing the traces, with few exceptions, is performed by daily labour (the daily rate of coolie hire is 8 annas, but occasionally amounts even to one rupee). In some forests of the Circle, this work has to be commenced at the end of December, and upon completion of the clearing, watchers upon Rs. 12 to Rs. 15 per mensem have to be entertained until the end of May or beginning of June. In only one block, Dowe, are we able to avail ourselves to any extent of evergreen forest or a broad stream. This, 31,750 acres in extent, is naturally protected upon three sides, and the fourth is cleared by the Karens, who undertake this work and the extinction of any fires for a lump sum of Rs. 100 per season. Particular mention is made in the review of Myodwin. This is a small isolated experimental teak plantation formed by Mr. Brandis some 20 years ago, it abuts on one side on a village, and on the others has fields or taungya cultivation in close proximity. A clean trace has to be kept to protect it from the taungya fires, &c., and a watcher entertained to patrol the paths. That the latter is not a luxury has been shown upon more than one occasion, when fires have been discovered inside the plantation, and which have originated therein, and when, had it not been for the watcher, the whole plantation would have been burned through.

RANGOON,
14th August, 1886.

POPPY.

WOOD FOR CIGAR-BOXES, &c.

I HAVE read the correspondence on this subject in recent numbers of the 'Forester' with much interest. I entirely agree with Mr. S. E. Peal in considering that 'tún or Poma' wood is the best we have in India for the purpose. There are of course others that will do, and among those referred to by "ex-Student" *Duabanga sonneratioides* and *Alnus nepalensis* might be used, but would not be nearly so good as several other woods that can be named, such as 'bakáyan,' *Melia Azedarach* (very like tún) and *Acrocarpus fraxinifolius*. To put down in a list such coarse woods as *Echinocarpus* and *Elæocarpus* is only to mislead.

The boxes in which Trichinopoly cheroots are usually packed are made of tún, those used in Coconada are made invariably of *Adina cordifolia*, but I doubt if that wood would be used if tún were easily procurable in the Godavari forests. I strongly advise those who want a good cigar-box wood to stick to tún, the Indian representative of the Spanish cedar, which I believe is *Cedrela odorata*.

It is worth noting here that according to the most recent determinations, neither the 'Lali' of Darjeeling nor the 'Súm' of Assam is *Machilus odoratissima*. The real *Machilus odoratissima* is the Punjab tree so common about Simla, the others will, I think, be found under other names, which I am sorry I do not yet know, when the next part of the 'Flora of British India' is published.

The three trees of Darjeeling, known to the Nepalese coolies as 'Lali,' 'Kawala' and 'Jagrikat' respectively will probably be described as distinct species, instead of being all placed, as hitherto, under *Machilus odoratissima*.

The 'Lepchaphal' has proved lately, from good flowers and fruit collected, to be not *Phœbe attenuata*, but a new species, to which Dr. King has given the provisional name of *Machilus edulis*.

I expect "ex-Student" is mixing up cigar-box woods with those suitable for tea-boxes. It would be rather too much to expect Mr. Sutherland to go to Darjeeling for such woods, when he can get tún and bakáyan from the N.-W. Provinces.

OOTACAMUND, *30th August, 1886.* J. S. GAMBLE.

GROWTH OF GRASS IN FORESTS UNDER PROTECTION FROM FIRE.

IN an official paper in the September number of the "Indian Forester" Mr. Broun says—"It is stated on good authority that in the Central Provinces under the influence of fire protection and irrespective of cover the grass becomes thinner and shorter every year until it is only about *half a foot high*." I wish this was a fact, but it *certainly* is not. During the past year the grass came up as luxuriantly and abundantly in the protected reserves as they ever did before protection from fire took place. I speak of reserves covering an area of over 1,30,000 acres in extent; some of these have been *continuously* protected from fire and grazing for 15 years, others for 10 and 8 years. The grass in very many open parts was over 3 feet high, and completely concealed the unburnt grass of the previous year.

C. P.

FENCING OF RESERVES IN JEYPUR.

AN extract on "Fencing of Reserves" taken from a report on the Jeypur State Forests by Mr. E. McA. Moir, Deputy Conservator of Forests, has been circulated for general information; but the only information given in this extract relates to the di-

mensions of the embankment and ditch, and that the average cost per mile was Rs. 100. It is obvious that this is very meagre and can lead to no useful results. What one wants to know is—the cost of labour at Jeypur—is the country flat or hilly—is the soil of clay, gravel, &c.—what is the object of this embankment with ditch—is it for protection from fires or from cattle, or from both—how many miles of it have been constructed—has it been *successful*—what is the annual cost of repairs, &c.? Unless information is given on these and other points the circulation of these extracts can do little good, and may result only in the needless expenditure of money in localities not suited for such methods of fencing.

A. J. C.

SNOW-FALL MEASUREMENTS.—In the Transactions of the Asiatic Society of Bengal for April 1886, appears a paper by Mr. H. F. Blanford on some snow measurements taken at Kailung in Ladak by the Rev. A. W. Heyde of the Moravian Mission. The object of the observations was to ascertain the relationship between the thickness of snow and the equivalent number of inches of rainfall. This was done in two ways—*first*, by cutting out with a rain gauge funnel the amount of snow on a definite area clean swept before the fall, melting it and measuring, and *secondly*, by melting and measuring that which fell into the rain gauge. The results were much more nearly similar than might have been imagined. From December 17th, 1885 to March 8th, 1886 inclusive, 70·36 inches of snow were recorded, giving, by melting, 6·40 inches of water, or 1 inch of water to every 11 inches of snow. The rain gauge was not used all the time, but from January 19th to March 8th, 5·06 inches of rain water were obtained by melting snow on an area equal to that of the rain gauge, while 5·25 inches were recorded by the gauge itself. In only one case did the daily readings differ by more than 0·05 of an inch. The previous year's experiments, not quite so accurately made, had given 1 foot of snow to 0·9 inch of water, or 1 inch of water to 13·4 inches of snow. The 1 inch to 11, is probably more nearly correct, but for rough generalities it is possible that 1 inch to a foot may be estimated.

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THE FOREST CONFERENCE AT DEHRA DUN.

A CONFERENCE of Forest Officers from all parts of India assembled at Dehra Dún, on the 15th October, and separated on the 24th, after a full discussion of several important questions.

The different provinces were represented as follows :—

Govt. of India, ...	Messrs. Berthold Ribbentrop, W. H. Reynolds, E. P. Dansey and E. E. Fernandez.
Madras, ...	Lieut.-Col. Campbell Walker.
Bombay, ...	Messrs. R. C. Wroughton and T. B. Fry.
Bengal, ...	Mr. E. G. Chester.
N.-W. Provinces, ...	Messrs. R. H. C. Whittall and W. R. Fisher.
Punjab, ...	Mr. H. C. Hill.
Central Provinces, ...	Lieut.-Col. J. C. Doveton was deputed, but was unfortunately prevented from attending.
Burma, ...	Mr. E. P. Popert.
Assam, ...	Mr. G. Mann.
Berar, ...	Lieut.-Col. G. J. van Someren.

Besides the above, Messrs. A. F. Broun, E. S. Carr, P. J. Carter, M. H. Clifford, N. Hearle, A. Smythies and Dr. Warth took part in the discussions, and Mr. A. Smythies acted as Secretary to the Conference, and is now engaged in editing a report of the proceedings, which will shortly be published.

Pandit Sundar Lal Pathak, Chief Forest officer to H. H. the Maharaja of Patiala was deputed by his State, to attend the Conference, but did not arrive in Dehra till after its close. The more important subjects of discussion were as follows :—

FOREST TECHNICAL TERMS, of which a list has been prepared.

THE COURSE OF INSTRUCTION AT THE FOREST SCHOOL, DEHRA DUN.

Appointment of Sub-Assistant Conservators.

Forest Working Plans.

Forest Rights and Settlements.

Grazing.

Relations between Land Revenue and Forest Officers.

Fire Conservancy.

Supply of Forest Produce to Public Departments.

After the close of the Conference on the 25th, several of the members joined in an excursion to see the improvement fellings in the Ramgarh forest, about 6 miles from Dehra.

FOREST ORGANIZATION FOR BEGINNERS.

(Concluded from page 397).

SECTION V.—PLANS OF OPERATIONS.

Chapter VIII.—General Remarks.

Object of plans of operations.

The plan of operations, which is required as a guide to the management of a forest, should show the proposed working of each series, separately, for a number of years, usually 10—20.

Series.

As already explained, when a number of groups are worked in connection with each other so as to make up the annual yields for a whole revolution, they are said to form a *series*, and one of the principal objects of the organizer should be so to arrange the cuttings that a sustained yield may sooner or later be attained. An ideal series may be likened to a sum of money invested in an undertaking which yields an annual return without trenching on the capital invested. The whole standing-stock represents the capital, and the annual yield of the series, in which a yield equivalent to the increment only is exploited, represents the interest on the money invested.

Each series of a forest should be treated independently as a separate unit, and have a distinct plan of operations. In selecting groups for any particular series, it is essential that they should be capable of the same treatment and of, practically, the same revolution. It would not do, except as a temporary arrangement, to put groups of very different revolutions in the same series—a group subject to a revolution of 60 years, for instance, in the same series as a group subject to a revolution of 100 years, nor a coppice-group in the same series as a seed-

ling-group. At the same time, absolute uniformity in the age of exploitation of all groups is not to be expected, and the reader will have discovered long ago that the age of exploitation and the revolution of a group may be two very different things. The latter indicates merely the average age at which, on a general view of the requirements of the whole series, it appears desirable to cut groups, whereas, the actual age of exploitation is determined by special, and often unforeseen, circumstances (loss of vigour, the exigency of a good sequence, and so forth), and may differ from the revolution chosen by 10—20 years, or even by a much longer period in exceptional cases.

It is also desirable that groups of the same series should not be of very different qualities, because the most advantageous revolution for a species growing in a favourable situation may be very different from that of the same species growing in a bad one, and because the periodic areas are more difficult to regulate on variable than on uniform stations.

It is further desirable that groups composing a series should not be widely dispersed, nor straggling in numerous small detached patches. When a small patch foreign to the surrounding mass occurs in an otherwise uniform series, it should either be treated separately and excluded from the series, or gradually absorbed by changing its mode of treatment, or by substituting for it another species, if necessary. Ineradicable differences of station, species, or treatment, may necessitate the exclusion of groups: for instance, when it is considered advisable to treat a group on an exposed hill-top by the method of selection, but the lower-lying groups by a more regular method: again, a patch of swampy ground, occurring in the midst of a teak-tract may necessitate its permanent cultivation with water-loving species, to which the same treatment as that which is best for the teak may not be applicable.

It is also desirable to have a suitable gradation of age-classes, and that groups belonging to one series should be separated from those of other series by well defined artificial, or natural, boundaries, such as roads, rides and rivers.

The organizer will seldom, if ever, be so fortunate as to find all the qualities of a good series united in one forest, and when this is not the case, he will have to take the good with the bad, and make the best disposition that adverse circumstances admit. The first step to take is to decide roughly the treatment and revolution best suited to each species and station. Those to which the same treatment and revolution can be applied are then scheduled according to age-classes. The areas occupied by the latter are thus presented in a concise form: a good general view of the situation is obtained from maps coloured so as to show the age, class and species of each group; and the organizer, assisted by his notes, is then in the best position to decide how many series to have and which compartments to select for each.

The Revolution.

It may appear to the uninitiated the simplest thing in the world to determine the most advantageous revolution for a group or series. Any one unacquainted with the subject would naturally choose a revolution calculated to produce the highest priced material, and would, in all probability, thereby obtain a return of less than one per cent. on the capital invested in the forest, instead of three or four per cent. which it may be reasonably expected to yield. The matter is, therefore, not quite as simple as it may appear to be at first sight for any one who wishes to know the revolution which is likely to pay best.

As already observed, the term *revolution* is used to denote the period which has been fixed to elapse from the time of the production of a tree, or group, to the time of its being exploited. It does not necessarily correspond to the age at which a tree is harvested, because trees have sometimes to be cut, or fall from natural causes, long before the revolution decided on has been completed.

The length of the revolution generally depends on the special object of the proprietor. This may be to obtain from the land the largest possible average return (1) of material, (2) of money, or (3) the highest possible interest on outlay, or his object may be to adopt the revolution best suited to (4) natural regeneration, or (5) some special technical purpose. Revolutions fixed with a view to meet such special requirements are called, respectively, the revolution of the largest mean yearly yield (1) in wood, (2) in money, (3) the financial, (4) the physical, and (5) the technical.*

1. *The revolution of the largest return in wood.*

By dividing the cubic contents of a tree or group, by its age, we get what is called its average annual yield, or, for the sake of shortness, *average yield.* The revolution which affords the highest average yield of wood obviously corresponds to that which gives the greatest material yield.

In the Table of yields at page 98, the average yield increases steadily up to the 48th year of age, when it begins to sink and never rises again. The revolution of the largest return of mate-

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* Besides these, some writers refer to a "composite revolution," which M. Nanquette has defined as (1) that revolution which gives the largest possible quantity of material combined with the highest possible rent, or (2) which gives the largest and, at the same time, the most useful yield. By "useful material" is to be understood that which fetches the highest price per cubic foot; economically considered, it may, therefore, be far from the most useful, and, in any case, since the average material yield of a group culminates at a comparatively early stage, while the highest prices are only obtainable for very old trees, it would generally be quite impossible to combine the two qualities.

As regards the other kind of composite revolution, it should be noted that the revolution of the largest possible quantity of material may by chance coincide with the highest possible rent, but it cannot be made to do so.

rial would, therefore, be about 50 years for a group yielding the returns shown in the table.

This method of determining the revolution generally leads to very short revolutions.

2. *The revolution of the highest average money-yield.*

This is found in the same manner as the last, the average yield in money after deducting all annual expenditure, taking the place of the yield of material.

In the Table at page 487 the average yield of money increases steadily up to the 120th year of age, beyond which the table does not go. The revolution of the largest average money-yield for a group yielding the return shown in the table would, therefore, be not less than 120 years.

This way of determining the revolution invariably leads to very long revolutions, as well as to low returns on capital outlay, because the interest on disbursements which are not recouped for many years, and the discount on prospective yields are not taken into account.

The financial revolution.

An account of the methods which may be employed in determining the financial revolution is beyond the scope of these papers. Considering, however, the importance of the subject, it is desirable to give the beginner a better idea of the meaning of the term than is apparent from the bare statement that its principal object is to obtain the highest possible return on capital-outlay compatible with a good sylvicultural system. This capital consists of the cost of cultivation, of the interest chargeable on the value of the land during the revolution, and on a sum representing the interest, during the revolution, on the capitalised value of all annually-recurring expenditure, such as taxes and expenses of supervision.

Taking a plot of ground about to be stocked with seedlings, it is evident that we shall not be able to realize any return on expenditure (excepting that from thinnings and minor produce) until the end of the revolution. It is, therefore, necessary, in the first place, to calculate at compound interest the prospective amounts of all disbursements and receipts at the end of the revolution. In this manner, the values of receipts and expenses, which do not fall due on the same day, are reduced to their proper values on one particular day, namely, the last day of the revolution. By deducting the expenditure, thus obtained, from the amount of receipts, we shall get the prospective profit at the end of the revolution, with the exception of the cost of cultivation, which can be more conveniently brought to account at the beginning of the revolution. The value of this sum discounted to the beginning of the revolution will give, after deducting the cost of cultivation, the net profit on the transaction, and

the revolution which affords the highest net return, calculated in this manner, is evidently the most profitable one to adopt.

If, for instance, H_r represent the value of the crop in the r-th year, that is to say, at the end of the revolution : B the present value of the land : c the cost of cultivation : V a capital yielding the interest required to defray yearly-recurring expenditure : P the profit at the beginning of the revolution : and p the rate of interest to be employed in the calculation : we should then have

$$P = \frac{H_r - (B + V)\,[(1{\cdot}0\,p)^r - 1]}{(1{\cdot}0\,p)^r} - c.$$

The cost of the land, with interest, up to the end of the revolution, amounts to B $(1{\cdot}0\ p)^r$*; but, as we require only the interest on the capital, we must deduct B from this expression, when it becomes B $(1{\cdot}0\ p)^r$ — B, or, in a more convenient form, B $[(1{\cdot}0\ p)^r - 1]$. In the same way, the interest on V is found to be V $[(1{\cdot}0\ p)^r - 1]$. Therefore the whole amount to be deducted at the end of the revolution from the value of the cuttings amounts to (B + V) $[(1{\cdot}0\,p)^r - 1]$. To get the value of this sum at the beginning of the revolution, it must be divided by $(1{\cdot}0\ p)^r$. Finally, the cost of cultivation is deducted from the result in order to obtain the net profit or loss of the speculation.

If any intermediate receipts are to be expected from thinnings or minor produce, their values at the time of falling due would have to be carried forward with compound interest to the end of the revolution, and added to the other receipts ; or, to state the case in general terms, if an intermediate receipt D_a is expected in the year a, it would appear in the form $\frac{D_a\,(1{\cdot}0\,p)^{r-a}}{1{\cdot}0\,p^r}$. The general formula is, therefore,

$$P = \frac{H_r + D_a\,(1{\cdot}0\,p)^{r-a} + D_b\,(1{\cdot}0\,p)^{r-b} + \&c. - (B + V)[(1{\cdot}0\,p)^r - 1]}{(1{\cdot}0\,p)^r} - c$$

When D_a, D_b, &c., represent intermediate receipts in the years a, b, &c.

In order to determine the financial revolution of a group, it is of course necessary to know the probable value of the material to be produced from period to period. Supposing we have experiential tables showing the probable returns per acre for a given species growing under the conditions assumed in the

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* The formula for calculating compound interest is $A = P\left(1 + \frac{p}{100}\right)^r$ or, in the above form, $A = P\,(1{\cdot}0\ p)^r$, when A represents the amount, P the sum invested, p the rate of interest, and r the number of years the investment runs. From this formula, the present value, P, of a sum, A, which falls due r years hence may be deduced : $P = \frac{A}{(1{\cdot}0\,p)^r}$.

tables, and that these returns, neglecting intermediate receipts, are those shown below. Taking $p = 3$, $V = 10$, $c = 10$, $B = 10$, the profits per acre for revolutions proceeding by differences of ten years are shown in the last column of the table.

Revolution, r years.	Value of group, Rs.	$(1{\cdot}03)^r - 1.$	$B + V$	$(1{\cdot}03)^r$	$c \times d$	$b - f$	$g \div e$	Net profit at beginning of the revolution. $h - 10.$
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	Rs.
50	128	3·38	20	4·38	67·6	60·4	14	4
60	203	4·89	20	5·89	97·8	105·2	18	8
70	312	6·92	20	7·92	138·4	173·6	22	12
80	462	9·64	20	10·64	192·8	269·2	25	15
90	649	13·30	20	14·30	266·0	383·0	27	17
100	874	18·22	20	19·22	364·4	509·6	27	17
110	1,146	24·83	20	25·83	496·6	649·4	25	15
120	1,429	33·71	20	34·71	674·2	755·8	22	12

According to this estimate, a revolution of 90—100 years affords a maximum profit of Rs. 17 per acre, and 90—100 years would, therefore, be the most advantageous revolution for the group.

4. *The Physical Revolution.*

This has been already defined as that best suited to natural regeneration. General and special rules for its determination are laid down in books on sylviculture. It may vary considerably according to circumstances, for the same species of tree, and depends mainly on the kind of tree, station, and régime (coppice or seedling-forest).

The Technical Revolution.

This has been defined as the revolution best adapted to yield wood suitable for certain technical purposes, such as timber for ship-building, props for mining, and cannot, therefore, be given in general terms.

Choice of a Revolution.

With the exception of comparatively small portions kept for ornament, private owners will generally wish to get as large a permanent revenue from their estates as possible, and for this purpose there can be no doubt as to the most favourable revolution—the financial. But when it is a question of forests belonging to the State, it is frequently urged that the financial revolu-

tion is unsuitable, and that, cost what it may, it is the duty of a Government to provide for all possible requirements of the community, and more particularly to prevent a diminution of the present supply of large timber. No doubt a good deal may be said in favour of this view. In the first place, it is undeniable that forests which can be cut down in a day may take years, or even centuries, to replace: that financial revolutions are comparatively short; and that it would never do to rely on private enterprise for the supply of the largest timber, more particularly as it seldom pays to grow it. Indeed, experience teaches that private individuals cannot be relied upon to provide a steady supply of even small timber, or firewood, which *does* pay; the temptation to exceed the capability of the forest, or to convert all the standing stock into gold, whenever money is required by the proprietor, is irresistible, and not to be restrained by other people's ideas of moral obligations to themselves and posterity. Opponents of a mercantile revolution consider, therefore, that a complete failure of the supply of large timber, which would perhaps take a century or more to replace, might easily be brought about by the general introduction of financial revolutions into a country: that such failure would certainly cause serious national inconvenience: and that it is, therefore, the proper function of Government to guard against any such contingency by adopting very long revolutions in State forests. Now, without denying that circumstances (those of protective forests, for example) are conceivable which would render it advisable for the State to keep a forest standing after it had reached financial maturity, advocates of the financial revolution may reply somewhat as follows:—As a general rule, it is the duty of a Government to make the most of the property entrusted to its charge, rather than to anticipate and provide for highly-improbable contingencies which, if they ever did threaten to arise, would certainly not in these days take everybody so entirely by surprise as some people would have us believe. The Government timber-forests of civilized countries are of vast extent: they are all systematically managed, or in a fair way to be so,* and could not, therefore, be swept away as if by magic, nor the standing-stock suddenly reduced to a great extent, because that would involve the sale of largely increased quantities of wood, which could not be quickly disposed of without great loss. The stock could, therefore, only be gradually reduced, and scarcity of any particular description of wood would be felt long before the standing stock of it was exhausted. But growing scarcity of any particular commodity would be accompanied by increased demand, and cause a corresponding rise in its price until the demand was satisfied, whilst a steady and lasting rise

* Those of the Continent of America, perhaps, alone excepted. In Canada, at all events, no real attempt seems to have been made in this direction.

in the price of any description of produce would cause an increase in its production under the financial system. In a well-regulated forest, therefore, this system would, it is maintained, serve as a gauge of the requirements of the public, and regulate the supply in sympathy with their most pressing wants.

Another consideration that favours the adoption of financial revolutions is that iron is now generally used for large structures in preference to timber, so that as long as these cheap, and apparently inexhaustible, substitutes are procurable, there can be little fear of the world's being inconvenienced by a falling-off in the supply of very large timber.

Of course it is not to be expected that the financial revolution can be accurately determined for seedling-forests. But a degree of accuracy is obtainable which amply suffices for all practical purposes: a few years more or less is not of the slightest importance. What is necessary, is a recognition of the soundness of the principle, and of the expediency of applying it more or less roughly whenever practicable. If this is done, we shall soon cease to hear of revolutions 300 years in length, or of duration still more absurd.

Proportion of Age-classes.

This may be shown for series subject to the method of regular cuttings, in a table similar to that at page 290, groups which are to be separated from the rest of the series being put in a separate column.

The age-classes are generally made to correspond to the periods. If periods are twenty years long, the age-classes should proceed by differences of twenty years.

Speaking generally, groups in process of natural regeneration by seed may be reckoned as belonging to the oldest class up to the time of the first secondary cutting. The quantity of old trees still standing is, however, the best guide. If we have, for instance, 100 acres of forest in process of regeneration, whose normal supply is altogether 400,000, but whose actual supply is found to be only 100,000 cubic feet, the average contents for a completely-stocked acre would be $\frac{400000}{100} = 4{,}000$ feet. There would, consequently, be the equivalent of $\frac{100000}{4000} = 25$ acres of the oldest class, and $100 - 25 = 75$ acres of young growth.

Wastes which it is intended to re-stock, should not be entered in an age-class until they have been re-stocked; but the last yearly coupe, or coupes, which is regularly re-stocked, should be entered in the first class.

The number of years necessary to realize the ideal state.

In series managed by the method of regular cuttings, an effort should be made to effect a practically normal state of the

age-classes of a series by the end of the first revolution, or within the term of years required to work through the whole forest. It may not, however, be advisable to accomplish this so quickly in forests in which the age-classes are very abnormal, on account of the sacrifice of immature, or the delay in cutting over-mature, groups, which a too sudden regularization might entail. It would generally be advisable, for instance, to exceed at first the normal coupe considerably, in a series of three age-classes, of which the first two were largely overstocked, and to reduce the annual coupe below the normal if they were considerably understocked.

Periods.

In series subject to the method of regular cuttings, very short periods are apt to hamper the executive, especially in forests naturally regenerated by seed, where greater freedom in locating the cuttings is necessary than in forests which are independent of "seed-years," and which can be regenerated with much greater certainty, regularity, and rapidity.

Another objection to very short periods is that they make the gradations of the age-classes too small.

On the other hand, very long periods are apt to allow too much license to the executive in carrying out the provisions of the plan.

Five to twenty years may be taken as limits. Thirty years were formerly the usual term for forests with long revolutions; twenty is now more general for seedling-forests, naturally regenerated, and ten for those regenerated by the method of clean cuttings, or, and this comes to the same thing, the twenty-year-periods are divided into sub-periods of ten years each.

Allotment of Groups to Affectations.

As a rule, the oldest groups should be cut first. Circumstances will, however, often prevent this arrangement. If we had, for instance, to choose between two groups, one old but vigorous, the other comparatively young, but sickly from mismanagement, attacks of insects, damage by fire, &c., or on account of the species being unsuited to the station, we would probably elect to cut the younger group first.

Again, in order to obtain a proper sequence of cuttings it may be necessary to cut younger groups before older ones; or in order to avoid having very large areas stocked with groups of about the same age where there is fear of damage by wind, or for other reasons.

Protective Cuttings.

These are very important in forests subject to the method of regular cuttings, and occupying sites exposed to violent storms.

As already explained, they consist in clearings 30 feet or more broad, made on the weather side of a group when it is young, so as to avoid the danger of suddenly exposing it when old to wind and sun, when the group in front of it is cut. The area thus cleared may be re-stocked with young growth, which then forms a protective fringe, or it may be left bare.

The usefulness of these protective cuttings in saving groups from premature cutting, or in rendering cuttings in due course possible may be very great in forests treated by a method of regular cuttings, and the principal reason why it is advisable to obtain, at the beginning, a rough idea of the course of the coupes during the whole of the revolution. The age up to which protective cuttings may be safely made in a group depends on the kind of tree, the conditions under which it is growing, and the station. Some species withstand wind much better than others ; conifers, especially those with only tracing roots, must be most carefully dealt with.

Extraordinary Thinnings.

These may be indicated when it is necessary to cut a group before its exploitable age, in order to hasten its growth, or its seed-producing power in case the group is to be naturally regenerated. When the thinning is very severe, it will be often advisable to introduce young-growth of shade-enduring species in order to protect the soil. If the group is to be cut within the next 20—30 years, this young-growth may sometimes be utilised in re-stocking the ground when the overwood is cut away.

Reserve-Groups.

Reserve-Groups are groups specially set aside for the purpose of making good any deficiency of material which may arise from unforeseen circumstances, such as an excessive estimate of the quantity to be exploited, losses owing to fire, insects, windfall, and so forth. They have not been found to answer. If taken from amongst exploitable groups with the intention of substituting from time to time younger groups, the arrangement interferes with a proper plan of cuttings ; and if they are chosen from younger groups, there is always the chance of their not being exploitable when required.

Several other expedients for establishing a reserve-fund have, therefore, been resorted to, such as lengthening the revolution beyond the proper term, reducing the estimated yield so and so much per cent., neglecting the increment of groups to be cut during the first period, reserving specially fine and vigorous trees as standards, &c.

Of these, the plan of lengthening the revolution, deducting a certain percentage from the estimated yield or reserving standards, appear to be the least objectionable ; but these and all others

involve a sacrifice of revenue in forests subject to a rational system of management, and it is therefore difficult to understand why a certain loss should be incurred in order to avoid a possible one. The case is not at all analogous to that of an industrial undertaking in which a reserve-fund is formed. In the latter case no loss is incurred by the formation of a reserve-capital, which is invested either in the business itself, or in other funds producing interest at the full market-rate in proportion to the security they afford; whereas in forests, the reserve is invested at a lower rate of interest, in funds, *i.e.*, forest, which do not offer greater security than if they were made to return the proper rate on capital-outlay. How this question is decided may not be a matter of very much importance; but as the principle of establishing reserve-funds in forests appears to be wrong, the simplest and best plan is evidently to dispense with them altogether.

CHAPTER IX.—PREPARATION OF PLANS OF OPERATIONS.

As this plan is intended to furnish the *raison d'être* of the proposed general plan of management, together with detailed instructions for the next ten or twenty years, it should commence with a general description of the forest and of the circumstances which have led to the proposed system of management. This account can be compiled from the facts collected during the examination of the forest. It should be condensed; only essential points being noted in order that the leading features may not be obscured by a mass of detail.

These introductory remarks may comprise all, or part, according to circumstances, of the following particulars and any other matters of interest.

1. THE ACTUAL STATE OF THE FOREST AND ITS SURROUNDINGS.

This should comprise a short history and description of the forest :—General topography, station and tenure; prevailing species; past management, expenditure, and receipts. Circumstances affecting its general management, such as the requirements of the surrounding population, markets, rights, and privileges, the existence in the vicinity of industries requiring a steady supply of forest produce. Particulars regarding communications and forest offences and means of preventing the latter.

2. CIRCUMSTANCES AFFECTING THE YIELD.

Reasons for the series and revolutions chosen; and for changes if any, of régime or species. Reasons for the methods adopted for determining the annual yield and contents of groups.

The probable state of the age-classes at the end of the revolution may be noted. Circumstances not now affecting the value of the produce but likely to do so, such as the construction of new or improved lines of communication, the starting of new industries (mines, factories, &c.). Directions in regard to the general management of the forest; such as directions as to the mode of carrying out the main-cuttings, thinnings, draining, and cultural operations. Reasons for alterations, if any, in the executive or protective establishments. Reasons for the system of differentiation adopted, and for any proposed new lines of communications.

3. Yield.

General statement of past and estimated future annual yield from main-cuttings, thinnings, and minor produce (all separately).

The plan of operations should include the following:—

(1). General plan.
(2). Statement of boundaries (in the form shown at p. 291).
(3). Of compartments and groups (in form at page 289).
(4). Of age-classes (form at p. 290).
(5). Detail-plan of main-cuttings.
(6). Detail-plan of thinnings.
(7). Statement of total estimated yield.
(8). Regeneration and cultivation-plan.
(9). Maps.

General Plan.

This is intended to give a general view of the present state of the forest, and its working for the next ten years, or for a longer period.

It may be drawn up in the following form for series treated by the method of regular cuttings. For forests exploited by the selection-method, and for the overwood of stored coppice obvious alterations are necessary: the number of trees of a class takes the place of area under the headings *age-class* and *periodic yield*, and the yield of the test-tree of a class that of the class-yield per yield acre, and, when the number of trees regulates the yield, columns will be necessary showing the numbers of each class to be cut, for the column showing the age of groups, the range of ages (*e.g.*, 5—40 years) or the range of diameters (*e.g.*, 0—10 inches), may be substituted. When the yield is given in cubic feet a column showing the rate of growth per cent. should be given for each age-class, or for each diameter-class if the latter be substituted for age-classes.

If there are other series in the range, separate statements should be made for each. A general statement may then be drawn up of the operations to be carried out during the first period, or decade, for the whole forest.

GENERAL PLAN OF WORKING.

The First Series of Kodali Range.

Revolution 60 years.

Locality.	Compartment.	Sub-compartment.	Area.	Quality of Station.	Quality of Crop.	Density.	Species, Régime, *Mode* of Treatment.	Age of Group.	Contents per Acre.	Age-Classes. 1-20. Area.	1-20. Contents.	21-40. Area.	21-40. Contents.	41-60 and over. Area.	41-60 and over. Contents.	Unstocked area.	First Period.—1887-1906. First Decade. Area of Coupe.	First Decade. Yield of Material. Per Acre.	First Decade. Yield of Material. Total Yield.	Second Decade. Area of Coupe.	Second Decade. Yield of Material. Per Acre.	Second Decade. Yield of Material. Total Yield.	Second period.—1907-1926.	Third period.—1927-1946.
			acres.						c. ft.	acres.	c.ft.		c. ft.	acres.	c. ft.	acres.	acres.	c. ft.	c. ft.	acres	c. ft.	feet.	acres.	acres.
Belmal,	1	a	10	II	II	1·0	Terminalia seedling-forest clean cuttings.	15	..	10	..	..	..	..	..	..	..	..	..	1	2,300	2,300	..	9
,,	..	b	5	,,	,,	,,		80	7,000	..	..	..	..	5	35,000	..	5	7,250	36,250	..	..	..	..	..
,,	..	c	20	,,	,,	,,		5	..	20	..	..	..	..	..	..	..	..	..	T	..	..	..	20
,,	4	a	32	,,	,,	,,	,,	30	..	..	..	32	73,600	..	..	..	T	..	..	..	..	..	32	..
,,	..	b	3	,,	,,	,,	,,	90	7,500	..	..	..	..	3	22,500	..	3	7,700	23,100	..	..	..	..	..
,,	..	c	10	,,	,,	,,	,,	15	..	10	..	..	..	..	..	..	T	..	..	..	..	..	..	10
,,	7	a	18	,,	,,	,,	,,	5	..	18	..	..	..	..	..	..	..	..	..	T	..	..	..	18
,,	..	b	17	,,	,,	,,	,,	60	5,400	..	..	..	..	17	91,800	..	..	..	..	13	6,650	86,450	4	..
,,	..	c	12	,,	,,	,,	,,	5	..	12	..	..	..	..	..	..	T	..	..	..	..	..	..	12
,,	8	..	50	,,	,,	,,	,,	70	6,300	..	..	..	..	50	315,000	..	28	6,650	186,200	22	7,250	159,500	..	..
,,	9	a	30	,,	,,	,,	,,	40	3,300	..	..	30	99,000	..	..	..	T	..	..	..	..	..	30	..
,,	..	b	5	,,	,,	,,	,,	..	..	..	..	..	..	..	..	5	..	..	..	T	..	..	..	5
,,	..	c	8	,,	,,	,,	,,	50	4,400	..	..	..	..	8	35,200	..	..	..	..	..	..	..	8	..
Total,	..	..	220	,,	,,	,,	,,	..	..	70	..	62	..	83	..	5	36	..	245,550	36	..	248,250	74	74
Estimated Average Annual Yield,																..	..	..	24,555	..	..	24,825	..	..

Remarks.

1*b*. Protective cutting.

9*b*. To be planted up at once with terminalia seedlings, at distances of 4 feet, in lines 4 feet apart.

Underlined areas are those which are to be couped and re-stocked during the first period.

Those marked T are to be thinned.

The increment of groups was estimated by means of local experiential tables accompanying this statement.

Detail-Plan of Main-Cuttings.

This may generally be drawn up in the following form. But it will not always be possible to give the area; for overwood in stored coppice and forest exploited by the primitive method, for example (see above). In cases of natural regeneration, when the old crop is only gradually removed, it will suffice to put down in red ink an area proportional in size to the quantity of wood remaining to be cut, making a note to that effect in the remarks column (see also remarks, p. 223).

Proposed Main-Cuttings 1887-96.

Locality.	Compartment and Sub-compartment.	Area of coupe.	Species.	Age-class.	Quality class.	Cubic contents. Feet.	Remarks.
Belmal,	2*b*	5	Terminalia.	III.	II.	36,250	2*b*.—At beginning of decade. 5*b*.—Ditto.
"	5*b*	3		"	"	23,100	
"	8	28		"	"	186,200	
Total, ...	...	36	...	...	...	246,550	
Average yearly yield, ...						24,655	

The above form should be on the left side of the sheet, and the following on the right. The proposed cuttings can then be conveniently compared with the actuals.

The quantities should be shown separately for different qualities of wood (logs, poles, firewood, &c.), or at all events, timber and firewood should be kept separate.*

* The classification adopted will, of course, depend on local circumstances. In many places, firewood would not be classified at all because unsaleable, and what may be valuable only as firewood in one country, may be used for constructive purposes in another.

MAIN-CUTTINGS ACTUALLY CARRIED OUT.

Compartment.	Decade 1887—1896. 1887. Area.	1887. Quantity.	1888. Area.	1888. Quantity.	1889. Area.	1889. Quantity.	1890. Area.	1890. Quantity.	1891. Area.	1891. Quantity.	1892. Area.	1892. Quantity.	1893. Area.	1893. Quantity.	1894. Area.	1894. Quantity.	1895. Area.	1895. Quantity.	1896. Area.	1896. Quantity.	Remarks.
5*b*	3	26,540																			Only 27 acres of compartment 8 were couped owing to windfalls in 7*b*, from which the full yield was made up.
2*b*	...	...	3·5	24,610																	
				&c.		&c.															
Total,	3	26,540	3·5	24,610																	

DETAIL-PLAN OF THINNINGS.

These should be scheduled in the same manner as the main-cuttings, the actuals and the estimate being recorded on opposite sheets.

As regards the quantity and quality of the intermediate cuttings, the usual plan is to make the estimate by means of experiential tables of average returns of groups of about the same age and of the same species. Much depends on previous treatment and on how a group originated; density and station are the most important factors to consider, and the results of previous experience may be modified as each case appears to require.

When neither local nor general tables exist, some data will probably have been collected during the examination of the forest which will serve as a guide.

Often thinnings have no value, or they are removed by permit-holders and cannot be calculated on. In such cases it is *needless to observe that there is no object in estimating the* quantity.

STATEMENT OF TOTAL YIELD.

This may be drawn up in the following form :—

Abstract of estimated total yield for Decade 1887-96.

Aggregate area of coupes.	Main cuttings, cubic feet.			Thinnings, cubic feet.			Grand Total.
	Timber.	Firewood.	Total.	Timber.	Firewood.	Total.	
Total, ...							
Mean yearly yield, ...							

REGENERATION AND CULTIVATION-PLAN.

This will comprise instructions for filling up blanks, cultivation of wastes, and regeneration of groups. The proposed plan should be written on the left side of the sheet and the details of its execution on the other.

The following form may be used :—

Left Side of Sheet.

CULTIVATION-PLAN.

FIRST DECADE 1887-1896.

Work Proposed.

Compartment.	Filling up of blanks.	Cultivation of wastes.	Regeneration of group.	Remarks.
1*a*,	...	...	3	To be taken in hand at once.
2*a*,	...	8	...	
	&c.	&c.		

Right Side of Sheet.

WORK ACTUALLY CARRIED OUT.

Compartment. No.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	Total.	Remarks.
	Area, Acres.											
1*a*,	3	...	...	...	...	...	...	...	...	...	3	Terminalia plantation 1 year seedlings at 4 feet distances.
2*a*,	8	...	...	...	...	...	...	...	...	...	8	Waste to be stocked with alternate rows of teak and bamboo.
			&c.		&c.							
Total,												

Maps.

The following maps will be required by the Executive :—

(1). Group-Map.
(2). Working-Map.
(3). Inspection-Map.

Group-Map.

This map should be on a smaller scale than the original map ; about 4 inches to the mile, $\frac{1}{15840}$, will generally suffice. The groups should be indicated by colours, each kind having a different colour, and each age-class having a certain depth of colour, the youngest age-class being lightest, and the oldest darkest. A good general idea of the proportion and position of the age-classes and species of forests subject to the method of regular cuttings is thus obtained at a glance.

Working-Map.

This should be a copy of the original map, on the same scale, and not coloured. It will be required for detail work, such as boundary-mark inspections and measurements, and should be on a scale large enough to show every bend and boundary-mark, and to admit of accurate measurements being made from it.

Inspection-Map.

This map is required for general purposes, such as inspections, and should, therefore, be made of convenient size, on a scale which may be made the same for all forests belonging to one proprietor, or may depend on the size of the range. The 4-inch scale $\frac{1}{15840}$, is a convenient size. The boundary-marks are not shown in this map, as it is not generally large enough for that purpose ; but all rides, roads, compartments, sub-compartments, streams, and salient features of the country should, if possible, be filled in.

5. Booking Results and other details.

A record should be kept by the Executive of—

(1). Changes, if any, affecting survey-details.
(2). Details of cuttings, actual and proposed, for main-cuttings and thinnings, in the forms given above.
(3). Details of cultivation actual and proposed in the forms given above.
(4). Comparative abstract, showing the estimated and actual quantity of cuttings, together with the sums realised by their sale.

(5). General abstract of receipts and expenditure.
(6). Estimated and actual quantity of, and receipts and expenditure on account of, minor produce.
(7). Abstract of average gross and net value of a cubic foot of wood, arranged according to species and régime.

Changes affecting Survey-Arrangements.

The chief points to note are changes of absolute area on account of sales, purchases, exchanges, &c. Increase, or decrease, in the area of stocked as compared with unstocked land, on account of new rides, roads, the stocking of wastes, newly-acquired land, &c. Alterations in the position of boundary-marks. Alterations which do not affect the relative proportion of stocked to unstocked area, such as the laying-out of narrow roads, building of bridges, cutting of ditches.

Changes outside the forest-area affecting the sale of its produce, such as new lines of communication, railways, factories.

All changes should also be noted on the map, if possible.

The yearly coupes should be marked on the map in pencil.

These changes should be put down in a note-book kept specially for the purpose, and of the following form :—

Changes which have occurred.	Remarks.
1887.	
Coupes.—1*a*, 3 acres cut clean, ...	Marked on map, Nov., 1883.
1888.	
Coupes.—1*a*, 2 acres cut clean, ...	Marked on map, Nov., 1884.
2*a*, 3 ,, ,, ...	
Boundary-mark, No. 115 missing, ...	Replaced by stone mark April, 1885.
&c.	

Abstract of the Estimated and actual Quantity and value of the Cuttings.

This should be drawn up for main-cuttings and thinnings (1) separately, and (2) together, as shown in the accompanying tables, subject to such modifications as may in each case appear necessary.

1. *Main-Cuttings.*

Year.	Actual area of coupe.	Estimate.			Actuals.			Value realised.		The actuals as compared with the estimate are					
										Timber.		Firewood.		Total.	
		Timber.	Firewood.	Total.	Timber.	Firewood.	Total.	Gross.	Net.	Too much.	Too little.	Too much.	Too little.	Too much.	Too little.
		Cubic feet.			Cubic feet.			Rupees.		Cubic feet.					
1887	4·00	15,000	9,000	24,000	16,180	8,120	24,300	18,541	12,745	1,180	...	...	880	160	...
1888				&c.			&c.								

2. *Thinnings.*—The same form as above.

3. *Total Yield.*

The same form as the above, containing the sum of main-cutting and thinnings.

General Abstract of Receipts and Expenditure.

This is intended to show at a glance the gross and net yield of the forest, and may be drawn up in the form opposite, subject to such modifications as circumstances may require.

Estimated and actual Quantity of, and Receipts and Expenditure on account of, Minor Produce.*

This statement may be drawn up in the following form. When the receipts are small, or the produce is sold in a lump *for the whole forest, the information contained in the remarks* column of the General Abstract will suffice, and this detailed statement may be dispensed with.

Year.	Compartment.	Produce estimated.			Actuals.		The estimate is, as compared with the actuals.			
							Quantity.		Value.	
		Description.	Quantity.	Value.	Quantity.	Value.	Too much.	Too little.	Too much.	Too little.
1887	Whole forest,	Right of grazing in compartments not in fence,	...	700	...	975	...	...	...	275
				&c.	&c.					

* *Minor produce* is all produce not ligneous (fruit, game, &c.).

GENERAL ABSTRACT OF THE RECEIPTS AND EXPENDITURE.

Year.	Forest Area.			Wood sold.			Receipts.			Expenditure.							Net Return.		Remarks.
	Stocked.	Unstocked.	Total.	Timber.	Firewood.	Total.	On account of wood.	On account of minor produce.	Total.	For harvesting wood.	Harvesting minor produce.	Forest improvement, cultivation, &c.	Pay of protective *and other establishments.*	Rates.	Miscellaneous charges.	Total.	Total.	Per acre.	
	Acres.			Cubic feet.			Rupees.			Rupees.							Rupees.		
1887	220	10·5	230·5	16,180	8,120	24,300	18,541	1,000	19,541	5,796	0	150	500	100	45	6,591	12,950	56	1887.—The minor produce sold consisted of the following items, and was collected and removed by purchasers *themselves.* Rs. Right to wild fruits, ... 25; Do. grass, ... 975; *Total,* 1,000
1888	...	...	&c.	...	...	&c.													
1889	...	...	&c.	...	...	&c.													

ABSTRACT OF GROSS AND NET VALUE OF A CUBIC FOOT OF WOOD.

This statement may be drawn up in the following form, subject to such modifications as circumstances may demand :—

Year.	Species and régime.	Number of cubic feet cut.	Gross value.	Net value. Total.	Net value. One cubic foot.	Remarks.
1887	Terminalia, clean cuttings, ...	4,000	1,000	650	·14	The average age of the Terminalia was about 60 years; of the Xylia about 80.
1887	Xylia naturally regenerated seedling-forest, ...	&c.	...	&c.		

CHAPTER X.—RENEWAL AND REVISION OF THE PLAN.

At the end of each period, or sub-period, the general plan of operation will have to be revised, and fresh plans framed for working the forest during the following period or decade.

Sometimes serious calamities such as extensive damage by insects and wind, renders an earlier revision necessary. In forests worked intensively, or which are very irregular, it is generally advisable to have intermediate revisions at intervals of five years.

RENEWAL OF THE PLAN.

The points to consider are (1), how the proposed plan has answered during the past period or decade. (2), the preparation of a new plan of operations for the next period or decade.

As regards the first point, it will be easily determined, if the records have been properly kept, by comparing the estimate with the actuals. Each item (main-cuttings, thinnings, minor produce, &c.) should be taken, *seriatim*, and compared with the estimate. Serious mistakes in the original plan, or in the manner of carrying it out, will soon be brought to light, and steps can be taken to avoid their recurring, if possible, during the next period. An examination of the work done in the forest will show whether the cuttings were suitably located and their sequences satisfactory; and also if other works, such as those

of regeneration, road-making and cultivation, have been satisfactorily carried out and with what result.

Before commencing to prepare a fresh plan for the next decade, or period, the map and statements should be corrected so as to show the existing situation. Sub-compartments, for which there is no longer any occasion, will be done away with on the map and in the statements ; and if new land has been taken up it will be apportioned to existing compartments, or made to constitute new compartments. It is well to prepare an entirely new map of groups.

It will then be necessary to make an entirely fresh examination and assessment of the forest, or, at all events, of groups which it is intended to fell during the next period. A detail-plan of operations, based on this estimate, is then drawn up for the coming term in precisely the same manner as the previous one, but it will not be necessary to repeat the general description which preceded the plan for the first period. A few introductory remarks will suffice to call attention to changes which may have occurred, and to the results of the working of the forest during the past period.

Revisions.

The object of these is to show how the plan of operations has worked, and to make such alterations within the prescribed limits of the original plan as appear necessary, but neither fresh assessments of groups, nor a working-plan for the next decade or period, is made. The scope of new revisions is, therefore, much more limited than that of renewals, and they partake more of the nature of an inspection than of a revision. They are, therefore, most useful in forests, such as those belonging to the State, in which the work of the executive is controlled by superiors. They are also useful in cases in which unforeseen circumstances, such as windfalls on a large scale, or the sudden demand for a particular kind of produce, necessitate a change of working. It will then be a question whether an entirely new plan should be framed or not, or if the old one can be altered sufficiently to satisfy the new conditions.

SECTION VI. CONVERSIONS.

Chapter XI.

Simple-coppice, stored coppice, and forests which have been treated by the primitive method, have sometimes to be coverted into regular seedling-forest. Considerations of sylviculture may sometimes render such a conversion desirable, as is the case when the impoverishment of the soil necessitates a change of species and system (*e.g.*, from deciduous to coniferous forest).

Other considerations, again, may necessitate a change, such as questions of finance, or the wish to attain a more simple and regular system. Generally speaking, the composite method is not suited to very large forests, because the personal attention of a skilful manager is required for nearly all operations in the forest, and he will seldom have time to attend to them thoroughly in extensive series. The principal objection to the primitive method is the difficulty of determining the sustained yield and of ensuring the regeneration of the forest.

Grebe divides the material to be exploited in the conversion of primitive forest or stored coppice, to regular seedling-forest, into :—

(1). Main-cuttings of the groups to be converted.
(2). Improvement-thinnings of original standing-stock, or cuttings which prepare the way for the main-cuttings.
(3). Thinnings of converted groups.

The forest should be divided into affectations of equal, or nearly equal, area, according to the same author, who gives, as an example, the case of a forest of stored coppice to be converted in four periods to regular seedling-forest, alloting groups to affectations in the order shown below.

1st Period.

1. Groups which are thoroughly exhausted to be cleared off, and the ground re-stocked artificially.
2. Groups with tolerably dense young-growth (underwood), consisting mainly of vigorous seedling or coppice-shoots of hard-woods. Most of the latter to be allowed to stand and grow into high forest.

2nd Period.

3. Groups with sufficient overwood to allow a preparatory cutting for natural regeneration to be made, but mostly deficient as regards under-wood.

3rd Period.

4. Groups whose overwood is too sparse for a preparatory cutting, and which will, therefore, have to be prepared for it by improvement-cuttings and the retention of a large supply of stores.

4th Period.

5. Groups which are deficient in both over- and under-wood, but which can be sufficiently prepared for regeneration by filling up blanks during the first period, and by retaining a large number of stores from the under-wood.
6. The wastes and coupes, stocked during the first period, if necessary.

The course of the cuttings would then be as follows :—

Period.	Groups under Headings (1) and (2).	Groups under (3).	Groups under (4).	Groups under (5) and (6).
I.	Regeneration cuttings.	Preparatory cuttings.	Improvement cuttings.	Improvement cuttings.
II.	Improvement cuttings and thinnings.	*Regeneration* cuttings.	*Preparatory* cuttings.	Improvement cuttings and thinnings.
III.	Thinnings.	Improvement cuttings and thinnings.	Regeneration cuttings.	Preparatory cuttings.
IV.	Thinnings.	Thinnings.	Improvement and thinnings.	Regeneration cuttings.

The above example will serve to indicate the general course which events may be expected to take, each case being treated according to its special conditions.

The yield for the first ten years is based on an examination of the growth and contents of each group, or portion of a group, to be cut during the decade. It will not, however, be necessary to attempt to estimate the contents and increment of any groups beyond those which are to be worked during the first ten years.

The improvement-cuttings will, of course, include the removal of very old standards which are not suitable for natural regeneration, and it will, therefore, often be difficult to avoid felling an excess of large timber during the first period.

The groups of later periods should be fixed provisionally, as the soundness of the plan for the first period will thereby be more generally demonstrated. But as time goes on, it may be found necessary to transpose groups from one period to another, it being impossible to predict positively which groups will be most suitable for regeneration twenty or thirty years in advance.

The general principles to be followed in converting other kinds of irregular forest to regular seedling-forest are the same as for stored coppice. The worst groups, and those most suitable for regeneration, are cut first, and the rest "improved." A more simple plan is to regenerate the entire forest artificially, but that is not always a feasible one ; it is always a much more expensive method.

A TOUR IN JAPAN.

HAVING recently spent a month in Japan "en route" for America, some account of that remarkable country may interest the readers of the "Indian Forester." The empire of Japan consists of a collection of nearly 4,000 islands, the principal of which are Niphon, situated in the centre, Jesso in the north, and Kinsin in the south. The area of the empire is understood to be 149,000 square miles, or about 28,000 square miles more than that of Great Britain and Ireland, whereas the population is supposed to be about the same, *viz.*, 33 millions. The physical features of Japan are most variable, and mountains, valleys, plains and rivers, combined with an irregular coast, are everywhere picturesquely blended.

In the north the winters are cold and severe, and snow covers the mountains for several months, but in the southern part of the empire, snow seldom lies more than a few days.

The average rainfall is said to be about 50 inches, this amount being distributed over several months of the year ; the maximum number of wet days during May, June and September being 10 or 12, whereas during the other months, they do not as a rule exceed 4 or 5.

Earthquakes are frequent, and severe storms or typhoons, which sweep everything before them, are not uncommon.

The history of Japan as regards its relations with the outer world is most curious and interesting. Various unsuccessful attempts having been made for more than 300 years by the Portuguese, Dutch, Russians, Spaniards and British to enter into commercial intercourse with it, but without any satisfactory result.

In 1854 however, the Government of the United States eventually succeeded in negotiating a successful treaty, and the ports of Hakodadi and Simoda were opened as coaling stations and to commerce generally.

Great Britain, France and Russia soon followed, other ports being also opened, and since these events the country has made the most rapid strides towards civilization which has ever been made by any ancient or modern nation.

The ancient Government of Japan was constituted on a most peculiar footing, and consisted of the Makado or Emperor, whose power was merely nominal, the real ruler being the Tykoon or Shogun, who had at his back as supporters a powerful set of nobles or chiefs called Daimios. In 1868, however, a great revolution took place, which resulted in the suppression of the Tykoon, as well as a considerable limitation in the power and importance of the Daimios, and the assumption of full authority by the Makado. Since this important event, the whole internal arrangement of the country has undergone a complete revolution, and security to life and property ensured by the suppres-

sion of the numerous two-sworded men and other armed retainers of the Daimios. The Government of the country has now been remodelled on a European system, and the administration divided into different departments, the chiefs of which form a kind of Council presided over by the Makado.

The construction of railways, telegraph lines, roads and bridges is now making rapid progress under the direction of the various Government departments; a good system of Police has been established, and a fairly efficient army is being equipped on the German system.

As regards maritime matters Japan now possesses a fairly efficient navy, and most of the merchant steamers of Japan are well managed and efficient. Extensive dockyards have been started at Yokoska, near Yokohama, and a law has just been passed prohibiting the building of the old class of unseaworthy junks, their place being taken by schooners, brigs or similar craft.

The mineral wealth of the empire is important, and includes copper, coal, silver, lead, tin, sulphur, nitre, salt, lime, marble, gold and a few precious stones.

The peculiarities of the climate of Japan are reflected in its flora, the palms, bamboos and ferns, reminding the traveller of the tropics; the pines, oaks, elms, laurels, beeches, walnut, &c., recalling the vegetation of Northern Europe, whereas the azalias, camellias and evergreen oaks call to remembrance the shores of the Mediterranean. The flora of Japan is said to be particularly rich and interesting, and would form a most interesting study for the researches of the scientific botanist, but as I have no pretentions to the above title, I shall confine my remarks to a few general observations.

As far as I have been able to ascertain from personal observation and study of various books, the principal forest species of Japan appear to be as follows:—

Metz (*Pinus Thunbergii* and *densiflora*), both of which species appear to be very common throughout the empire.

Hinoki (*Chamæcyparis obtusa* and *pisifera*), both of which species form extensive forest in the Central and Northern islands.

Suji (*Cryptomeria japonica*), found planted throughout the length and breadth of the country, and especially near villages and round all shrines and temples.

Keaki (*Zelkowa Keaki*), kuri (*Castanea vulgaris*), much used for railway sleepers.

21 species of oaks,

25 kinds of bamboos,

30 species of cherries,

many species being grown simply on account of their flowers.

Numerous kinds of azalias, camellias, and laurels, besides various species of elms, maples, deutzia, hornbeam, viburnum, holly, olive, &c.

As regards characteristic plants of Japan, they may probably be enumerated as follows :—Azalias, camellias, *Cryptomeria japonica*, *Cydonia japonica*, chrysanthemums, Hibiscus, the Japan shrub peony, the famous water lily nasu (*Nelumbium surcifera*), asters, &c.

The principal forest trees common to Europe, which are mainly confined to the northern islands, are elms, beech, larch, aspen, wild cherry, ash, yew ; whilst amongst shrubs and other plants, the following are most common, ivy, honeysuckle, lily of the valley, monkshood, marigold, wood sorrel, poppy, chickweed, dock and dandelion. Palms are by no means common, and are confined principally to the southern portion of the empire.

Regarding the fauna of Japan, as far as my limited observations went, animals and birds appear to be particularly conspicuous, by their absence.

However, an examination of the museums at Zokio and an inspection of the skins offered for sale, it appears that the principal forest animals of Japan are black bears, most common in the south, and brown bears, principally confined to the northern part of the empire.

A few polar bears are also occasionally found on the shores of the northern islands, brought there it is stated by the numerous icebergs which strand on the coast.

A kind of spotted deer is fairly common, also a wild goat, which, however, only inhabits the highest hills, and a few wild pigs are found, but they are by no means numerous.

Besides the above animals, which may be said to be the most important forest quadrupeds of Japan, there are foxes, badgers, monkeys, otters, wild cats, weasels, and hares.

As regards birds a large number of European species exist, such as crows, larks, robins, thrushes, geese, ducks, snipe and quail. There are also a considerable number of representatives of Indian species, such as kites, jays, barbets, parrots, &c.

There are two or three kinds of pheasant, the principal of which is of a beautiful copper color, and is much sought after by sportsmen. Owing, however, to the natural expertness of the natives at trapping and snaring, game is said to be scarce, this being also the opinion of several sportsmen whom I happened to meet.

Certain game laws have, however, now been promulgated, and shooting is only allowed at certain seasons.

Reptiles are not very common in Japan, and as far as I could judge from a rapid inspection of the collection at Zokio, they much resemble in general appearance those found in the Himalayas.

As regards fishes, the seas and lakes of Japan team with fish of all kinds, including several European species, such as salmon, trout, &c.

Consequently fish forms a most important part of the food of

the inhabitants of these islands, who are said to be most expert fishermen.

On approaching the coast of Japan one is struck by the immense number of native fishing boats which are generally seen trawling in pairs, but as many as seven are sometimes seen in a line dragging immense nets.

The first port touched by steamers from Hongkong is Nagasaki, situated on the south-west side of the island of Kinsin, the approach to which much resembles a picturesque Norwegian fiord. On the right entrance to the harbour there is a fine coal mine, one of the most productive in Japan, which fact renders Nagasaki one of the most important coaling depôts in this part of the world. The harbour is considered a safe one, and at the time of our visit it was occupied by seven Russian, French and British men-of-war besides numerous merchant vessels of all nations.

The principal exports from the town of Nagasaki are camphor, *tea, vegetable wax, coal, &c.*

As the P. and O. steamer remained in port for several hours, we had time to run on shore and examine the town, the European portion of which we found to be clean, well built, and much resembling a French town. The native part is also clean and prosperous looking, and the natives themselves are most civil and polite to strangers.

As a rule throughout Japan even the poorest people are fairly well dressed, and few beggars are met with, either in town or country. The rural population and most of the inhabitants of the towns retain the national dress, which consists of a kind of long open dressing gown called a Kiminon, fixed round the waist by means of a sash.

The dresses of the men are generally of a sombre hue, blue being the color preferred, but those of the women are more lively, and especially on holidays are particularly gay.

The men generally wear hats of various patterns, the "Tam O'Shanter bonnet" being most fashionable, and the women do up their hair in a most elaborate manner. The ladies are also very partial to the use of chignons and large hair pins, and the fixing of their head gear is such an elaborate affair, that they recline with their heads resting on specially made blocks, in order that their hair may not be deranged. All wear wooden clogs of various shapes, but coolies and agriculturists generally wear straw sandals. During wet or cold weather overcoats of straw or oiled paper are generally used by the poorer portion of the population.

One of the most peculiar customs which first strikes the traveller in landing in Japan is to find all pack horses shod with straw. The shoes are fixed on in a simple manner, and as a matter of course only last one or two days, so that one finds horses' shoes strewn all along the roads in Japan.

The lion of Nagasaki is a hill called Sour, situated about three miles from the landing place, which is crowned by a temple and several tea houses, or small inns.

This temple is surrounded by fine clumps of elm, ash, pine, camellia, bamboo, camphor and cotton-wood trees, one of the latter being 30 feet in girth and 100 feet high.

After spending an hour or two pleasantly at this place, we returned to the steamer, and soon after steamed away for Kobi through the inland sea of Japan. Provided the weather is favourable and the traveller is fortunate enough to pass the best portions of the scenery by day-light, a sail through the inland sea must be very interesting, but on the occasion of my visit the weather was cloudy and misty, and some of the best parts were passed during the night.

However, we had a good view of that portion known as the Straits of Simonasaki and neighbouring islands, all of which are picturesque, and interesting.

The islands and coasts of this portion of Japan are all well wooded, principally with *Pinus Thunbergii*, oaks, elms and fine clumps of bamboo plantations.

Villages seemed to be few and far between, but those observed were well built, clean and flourishing. In their immediate neighbourhood considerable patches of neatly cultivated fields were to be seen, the principal crops being wheat, rape, beans and potatoes. Some of these fields situated on steep hill slopes are terraced in the same manner as in the Himalayas. The upper portion of the neighbouring hills are as a rule bare of tree vegetation, and the practice of firing the grass is evidently indulged in throughout Japan. No very satisfactory explanation of this practice was obtained, as cattle are seldom allowed to graze in Japan, and it is supposed that the firing of the grass is probably resorted to in order to get rid of an obnoxious kind of bamboo, and thus obtain a better crop of grass, principally for cutting for winter fodder, or for thatching purposes.

As a rule few cattle, except bullocks and cows, are kept in Japan, sheep being non-existent, owing it is said to the presence of a kind of bamboo which cuts up their insides, and goats and donkeys are also extremely rare. Nearly all the animals are stall fed, and during the whole period of my stay in Japan, I do not recollect of having observed an animal of any kind grazing in the jungles.

This happy state of affairs from a forest point of view, combined with an abundant rainfall, simplifies forest conservancy and plantation work very considerably.

Most of the inhabitants of these islands appear to be busily engaged in fishing, and numerous boats were everywhere passed, the fish caught being either salted or conveyed alive in tanks to the neighbouring large towns of Nagasaki or Kobi.

The run from Nagasaki to Kobi occupies about 40 hours, and as the latter town is not of much interest to travellers, I proceeded the following day to Kioto, the ancient capital of Japan.

The distance from Kobi to Kioto is about 50 miles, and the journey is easily performed in about three hours by means of a very well managed metre gauge railway. The railway plant for this line is said to have been manufactured by the Japanese themselves, and if so, the work has been done in a most creditable manner. All the officials are natives, and the traveller at once notes how appropriately the metre gauge system corresponds with the size of the men, both being in perfect harmony.

The principal timber used for railway sleepers in Japan is kuri (*Castanea vulgaris*), and they are said to last about 10 years. For the first 20 miles the line runs through an extremely fertile and well cultivated plain, having an average breadth of about 10 miles, the greater part of this area having been reclaimed from the sea or from the beds of the numerous water courses which traverse it. This has been effected by a complete system of embanking the sea shore, also the borders of about 20 streams which traverse this plain.

All these embankments, extending for about 5 miles inland, are substantially constructed on scientific principles, the sides next the streams being strengthened by willow planting, whereas the back slopes and neighbouring waste lands are all covered with pine and bamboo plantation. One peculiar feature of these embankments is the general use of bamboo baskets of various shapes filled with stones, which are much used for protecting embankments in Japan. These are made in the shape of bolsters, about 20 feet long and 18 inches in diameter, and are laid horizontally along the foot of the banks, others of various diameters up to 4 or 5 feet being placed on end.

The principal town passed is Osaka, which is considered par excellence the trading centre of Japan, and also contains the mint and extensive barracks for the housing of the Imperial troops. Besides this place several other towns and villages were passed, the whole country on both sides of the railway being carefully and elaborately cultivated.

All the intervening patches of waste or high land are devoted to the cultivation of tea, bamboos or clumps of pines.

On approaching Kioto the line passes through a picturesque valley, the low hills on each side being completely clothed with flourishing forest of pines, oaks, *Cryptomeria japonica*, bamboos, &c.

It was satisfactory to notice that some kind of system in the working of these forests is evidently followed, the hard woods being cut on the coppice system, whereas the pines are either clean cut and the area replanted, or a few reserves are left here and there for the purpose of re-sowing these areas naturally.

The town of Kioto is probably still one of the largest, import-

ant and most picturesque cities in Japan, and not long since it contained upwards of one million inhabitants, but since the transfer of the Makado's Government to Tokio the population has naturally decreased. The streets of this town are well laid out and kept in fair order, but the houses and buildings are not of a pretentious nature, being generally not more than two storeys high.

This arrangement is necessitated by the frequency of earthquakes, and the houses are generally built of timber and bamboos with tiled or shingle roofs, and all have consequently a most inflammable appearance. The result is that conflagrations are of frequent occurrence, and the last great fire which took place in 1846 reduced in a few hours, 500 acres of the town to a heap of ashes.

Fairly efficient fire brigades are now kept in most towns, and tall posts are everywhere erected for the purpose of viewing and signalling fires, but notwithstanding all these precautions, all the most important shops are provided with their own fire-proof safes. These are built in a peculiar manner of bricks and mud, with very thick walls, and heavy iron doors, and within these buildings all the most valuable property is kept.

On an alarm of fire being given, the doors are closed and the joints plastered over with mud, and after a conflagration has passed over a section of a town, these buildings only remain standing alone amongst the smouldering ruins. The town of Kioto is famous for its temples, there being in all 350, the number of Buddhist and Shinto priests connected with these establishments being upwards of 15,000.

The most important of these temples is one called Hongwanji, which covers an area of about 30,000 square feet, and is about 100 feet high, the whole erection being of pine and elm timber. The interior of the temple is divided into variously sized chambers, the walls of which are tastefully decorated with elaborate carvings, paintings and lacquer work, &c.

One peculiarity of all Japanese temples is a kind of triumphal arch, called a Torie, which generally spans the entrance, and which consists of two upright and one horizontal beam painted or lacquered red. Another peculiar feature is the immense number of stone or bronze lanterns which generally line the entrance avenues, and are often from 10 to 12 feet high.

At the entrance to this temple there is an immense sacred Icho or Ginkyo tree, the scientific name of which is *Salisburia adiantifolia*, and which has peculiarly fan-shaped leaves.

In addition to *Cryptomeria japonica*, this tree is generally found planted near most temples in Japan, and is popularly supposed to pour out showers of water during conflagrations and thus protect the temples from taking fire.

In a fine grove of trees near the temple, we found several buildings inhabited by the priests, and surrounded by a neat

garden, which is ornamented with fish ponds, rustic bridges, stone lanterns, and trees and shrubs cut into fantastic shapes. In fact it is asserted that this style of garden, known as Dutch gardening, was borrowed by that nation from the Japanese.

In the immediate neighbourhood we next examined the restoration of the great Shinagsi Honag temple, which was destroyed by fire about 7 years ago. The pine beams being used in the construction of this temple are of immense size; some of them being as much as 54 feet long and 2 × 2 feet square, from which fact some idea of the size of the forest trees of Japan may be gathered.

The carpenters employed on this temple building seemed to be very expert workmen, and all the most complicated joints were being used in putting the various scantlings together. For moving, raising and placing the beams in position various kinds of capstans, windlasses, pulleys and levers were being used in a skilful manner.

Amongst various ropes and hawsers employed on this work, I observed one about 12 inches in circumference and 100 feet long, composed entirely of human hair, and which we were told had been presented to the work by a devotee, this kind of rope being supposed to possess certain great advantages of strength, durability, &c., not combined in any other material.

Amongst various other interesting sights at Kioto the traveller is of course taken to see the numerous "curio" shops, some of which contain the most extraordinary collection of bronze and lacquered ware, weapons, pictures, &c.

Kioto is also famous for its porcelain and cloisonne ware, as well as silk and crape, but the prices demanded for all these articles is as a rule exorbitant.

Various interesting excursions may be made to places in the vicinity of Kioto, one of which, *viz.*, that to the rapids of Katsuragowa I found most interesting, and shall now endeavour to describe. These rapids are situated about 12 miles from Kioto, the first part of the journey being accomplished by means of Jinrikshaw drawn by two coolies, the distance being easily run over in about 2½ hours, even though the road was hilly and in very bad order.

Immediately outside the town of Kioto the road passes through an extremely fertile plain measuring about 10 × 5 miles, the whole of which area is cultivated like a garden. The crops, which consist of wheat, rape, beans, peas and other vegetables, are cultivated in ridges, placed about 1 foot apart, which arrangement enables them to be irrigated, manured and weeded in a most thorough manner. All kinds of manure from the city is conveyed to this ground in buckets and stored in the fields in small tanks or tubs till wanted, and everywhere in Japan, even in the most out-of-the-way places, I noted that no manure of any kind was wasted.

Intermingled with the crops and situated on the higher patches of ground one observes numerous patches of tea, the bushes being placed in continuous lines like hedges about 2½ feet high and 2 feet apart. These bushes are also manured in a most careful manner, and in some cases I observed bamboo screens or "tatties" constructed over them, in order, I suppose, to protect the tender leaves from the sun.

The low lying swampy ground is devoted to the cultivation of rice, the method of cultivation being essentially the same as that followed in India, with the difference that a plentiful supply of manure is given, and in consequence the rice produced is of first rate quality.

The villages passed through were remarkable for their clean, neat and flourishing appearance, the people being all industriously employed and apparently happy and contented.

The food of the poorer classes apparently consists mainly of rice, fish and vegetables, such as beans, peas, a large kind of white radish, sea weed and bamboo shoots. Tea is extensively drunk by all classes, also a kind of mild beer made from rice, called saki.

En route to the rapids we encountered numerous small hand-carts drawn by coolies or a single bullock, and ladened with various kinds of forest produce, such as logs, poles, planks, scantlings, charcoal, fuel, faggots and lime.

I observed that all scantlings and planks were particularly well sawn, some of the latter being not more than half an inch thick. All fuel was split and neatly sawn up into billets of about 18 inches in length, and during my travels in Japan I never noticed a piece of wood unnecessarily hacked with the axe, the use of the saw being thoroughly well understood.

All charcoal and lime is made up in bamboo or grass baskets of about 20 lbs. weight. The faggots also were particularly neat, and I observed several carts loaded with pine roots, which circumstance points to the economical manner in which forest operations are conducted in Japan.

We passed several extensive areas devoted to the cultivation of a species of large bamboo, the young shoots of which are specially appreciated in Japan as food.

These fields generally consist of patches of good land, the standard bamboos being cultivated as single stems situated about 10 feet apart, the heads being lopped off at about 12 or 15 feet from the ground, in order it is supposed to increase the number of shoots from the rhizomes, and reduce the shade as much as possible. The fields are carefully cultivated, and straw or leaf mould plentifully applied. The young shoots are cut or broken over just as they are appearing above ground, and large quantities were to be seen for sale in every bazaar, their taste when well boiled, very much resembling that of inferior turnips.

After leaving the plain of Kioto the road crosses a range of

hills through which a tunnel of more than 200 yards long has been recently constructed. All these hills are well wooded with pines, oaks and elms, the forests being it is said the property of the State.

Along the sides of the road, and for a considerable distance up the neighbouring slopes, a broad belt of *Cryptomeria japonica* has been planted by the Engineer in charge of the road, the plants being put in 5 × 4 feet apart, and the plantations seemed to be flourishing.

The geological formation of these hills being of a friable description consisting of shales, gravel and sand, the neighbouring *slopes are subject to* landslips, and in several places I noted that regular lines of fascines had been constructed along the hill sides. These are situated about 20 feet apart, the spaces between being carefully planted up with oaks, pines, &c., in a careful and intelligent manner. After crossing the pass the road leads through more villages, in the neighbourhood of which I noticed numerous oak trees carefully treated on the pollard system: also *several temples, cemeteries and other enclosures surrounded by* neatly trimmed bamboo and *Cryptomeria japonica* hedges.

On arrival at the bank of the Katsuragawa river, we entered a large flat bottomed boat about 40 feet long by 8 feet broad, manned by four sturdy boatmen, and at once proceeded down the rapids. The descent of this river must be somewhat exciting for those unaccustomed to this kind of river navigation, and considerable expertness is required on the part of the boatmen to avoid striking against the numerous projecting rocks, the stream being in some places a roaring cataract.

The total fall in a distance of about 7 miles is about 200 feet, *and as there was a good supply of water at the time of our visit* we performed the voyage in about 1¼ hours.

The *central portion of* the river is to a certain extent prepared for navigation, a rough channel being formed by means of removing the loose boulders, the laying down of cribs loaded with stones, also by a free use of the long bamboo baskets already described. The beauty of the scenery of this river is extremely picturesque and must be seen to be thoroughly appreciated. On each side the steep sloping banks rise up to *about 500 feet above the river, the tops being covered with* fine pine forest.

The lower slopes next to the river have been cleared of all timber, but it was satisfactory to observe that extensive planting operations of *Cryptomeria japonica*, pine, oak, &c., were in progress, the young trees planted being apparently flourishing.

The beauty of the scenery of this river culminates at a place called Arashiyama, when the boat was abandoned, and the Jinrikshaw mode of travelling resumed back to Tokio, which is distant about 7 miles.

At this place we found a large number of the pleasure-seeking

inhabitants of Kioto thoroughly enjoying themselves in various ways, *viz.*, boating, fishing, or sitting in groups in small booths engaged in eating, and drinking tea or saki, the whole festivity being mingled with a good deal of banjo playing, accompanied by rather discordant vocal melody. From this place, the road back to Kioto passes through some very fine bamboo plantations, as well as patches of tea, the country in this part of Japan looking thoroughly prosperous.

There are several routes by land from Kioto to Yokohama, but I preferred the sea passage, so retraced my steps back to Kobi, and embarked on board a fine Japanese steamer called the "Jamiashiro Marw," by which we arrived at Yokohama in 33 hours. This ship is one of a considerable fleet belonging to a Japanese Company; is manned by European officers, and has all the latest improvements including electric light. It is reserved by the Japanese Government as a transport in time of war, and is capable of carrying 1,200 men.

E. McA. M.

(*To be continued*).

VOLUNTEERS FOR SERVICE IN UPPER BURMA.

THERE will probably be some officers from the dryer climates of India who will find that the climate of Burma does not suit them. It is to be presumed that Government does not intend that those who volunteer for service in Upper Burma should suffer for their zeal, and I think it would be but fair that they should be given the option of returning to the provinces from which they came, after, say, three years. Not in the class and grade to which they have in the meantime risen, but to their former position in the provincial list, where their names would still be retained, and they would be shown as "seconded." There is no doubt that promotion in the new province will be most rapid, in fact, most volunteers would ordinarily be sent on promotion; and those whom the climate suited would not care to go back to their provinces on reduction, as it were.

Three years' service in Burma would be obligatory, and after that each one would be called on to decide whether to come on to the permanent Upper Burma list or to return to his former province. The decision would be final, and, in the case of those electing to remain, their names would be removed from the other lists.

Otherwise, "volunteering" is likely to bear hard on some, and especially on those who come under the unfavorable leave and pension rules.

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THE FOREST CONFERENCE AT DEHRA DUN.

ALL of us who were at the Forest Conference, held in October 1886 at Dehra Dún, will allow with pleasure that the freest discussion was encouraged on all matters laid before the officers there assembled, and we may hope with reason that our meetings will bear good fruit in many ways. As a matter of course our observations and proposals were limited to what was immediately before us, and the Government in allowing us to meet and discuss the state of the Department and its wants expected us to keep within the four corners of the programme drawn up. In the pages of the "Indian Forester," however, we may expatiate more according to our own wills, and raise discussions which may possibly reach further.

I wish to carry to a higher point the discussion on the position of District Forest Officers, and to make suggestions regarding the organization of the Forest Department in its higher branches; to say a few words regarding the training of its controlling officers, and to point out what good purposes the Forest School at Dehra Dún may be put to.

The present system which gives a Conservator, with a varying number of officers under him, to each of the more important *charges can be greatly improved. In all thelarger charges, at* least, there should be a *Chief Conservator*, who should also be *Secretary to the Government in the Forest Department*, and he should be the sole administrative head under his Government and responsible to it alone. Under him should be *Conservators*, each in charge of a *Circle*. These Circles should be no larger than can be thoroughly well supervised, controlled and inspected by the Conservators, and should be divided into *Charges*, each under a controlling officer who should be placed in close accord with, and work under, the District Civil Officer in carrying out the scheme of forest management, which scheme, in all professional, financial and disciplinary matters, must be subordinate to

the orders of the Superior Forest Officers. Each charge should be divided into *Ranges,* each under its own *Ranger,* and the Ranges into *Sub-Ranges* and *Beats* under *Foresters* and *Forest Guards.*

The unit should be the Range, and the number of Rangers contemplated by Dr. Brandis for all India at, I think, 1,500 is not too large. The Rangers will, of course, be all men trained at, and passed out by, the Forest School. Given such Rangers and Ranges of manageable size the forests will be well protected, worked on proper principles, and *the revenue will increase to a vast extent.* Such Rangers will necessitate a very much higher standard of knowledge than is at present apparent among Sub-Assistant Conservators ; and it goes without saying that the officers who again control the Sub-Assistant Conservators and junior controlling officers must also be men possessing a really good general education and high special attainments. But such controlling officers will be discouraged, and their usefulness much limited unless they are placed in suitable positions, and unless they have large Departmental powers.

The Forest Department is now no longer in its infancy. It yields a large gross revenue with a very handsome surplus, and is daily increasing its capital and growing stock. The work to be done is not only special work, but is now organized and growing in importance. This is why we may ask that Conservators be placed in a higher position and in much closer contact with their Governments and Administrations. To do so will increase their efficiency, increase the revenue, maintain a higher standard of forest work, and so benefit the public estates and the public. These officers should be more independent, and be allowed to approach their Governments more directly, than is now possible, when they have to send up schemes and to receive orders through other channels which, however able, are still unprofessional. There are now, in the existing Forest Acts and in the means which every Government has of obtaining the opinions of its chief Civil officers, ample safeguards to prevent the undue preponderance of a Department. But when such opinions have been obtained and sifted the Government should *deal directly with the head of the Forest Department* as its administrative officer *and Secretary* in that branch. No practical difficulty exists which need prevent the initiation of such a measure. The men are there, among the Conservators, and among the officers who having done well at the German and French Schools of Forestry can now claim much Indian experience and a capital record of work done.

Some such scheme appears to be now needed. Each province should have its single administrative forest chief. Putting two or more Conservators into a province, each with equal and inadequate powers, and all of them under a Financial Commissioner, or a Board, or a Secretary, is not a good plan.

Next with regard to the training of the controlling staff. It is a pity that the age at which young men are sent out is not higher. It should be raised and a higher general education called for. After going through a special theoretical course at Cooper's Hill, the officers intended for the controlling staff should be sent to the Dehra Forest School to go through a two years' course there. Indian experience is what they want, and a practical training in Indian Forestry. At the risk of being classed with those you lately called "some conservative members of the Department," I cannot but say that my experience has shown me that, in the majority of cases, the young men sent out through Nancy have been of but limited use till they had gone through a somewhat lengthened experience out here. I do not wish to be misunderstood. I am not despising their training there, but it was all too short, and much of it gained in forests very unlike what most of them have to deal with here. And, except at the beginning of the system, they have come out too young. It may be objected that to raise the age for entrance and to prolong the course means money. India is not the place it once was, but yet it presents a fine field for Englishmen, and is still the land where the finest service can be found. With the hundreds of educated men at home who, if all one hears and sees and reads is true, barely succeed in gaining a livelihood, it is probable that fair pay and a position suited to their talents would attract men from the Universities. But they must be certain of fair pensions, fair furlough rules, and not be liable to changes in rules and to seeing others, with no higher education or talents than themselves, placed under better rules. In fact, the Forest Officer of India should be a member of the Covenanted Civil Service, and the Department should become an integral part of that service, and with prizes sufficient to keep men in it.

The Forest School at Dehra is, with the staff that we had the pleasure of meeting in October last, quite able to instruct any men who may be sent to that institution, and it does seem a waste of power that this well manned and well furnished and well housed School should not be utilized to a far greater extent than it now is by the Government. It should, under well considered regulations, be thrown open to the public, and in that case I believe that the School will not only turn out an ample supply of good forest officers for India, but also for other parts of the Empire. Australia, New Zealand, the Cape, Mauritius, Egypt even, are all in want of such men, and the Dehra School, with the pine and oak forests of the Himalayas on one side, and the varied forests of the plains on the other, is *the* place where the widest experience can with the greatest facility be brought to bear on practical forest training.

There is one point more on which I would touch. The pay and position of the Inspector General of Forests is lower than it should be, when the very responsible and heavy duties that he

has to perform over the length and breadth of India are considered. He draws less pay than a Collector of a single district. This seems to be an anomaly.

G. J. vS.

A TOUR IN JAPAN.

(*Concluded from page* 518).

YOKOHAMA is quite a European town, with good public buildings, hotels and fine private residences. Along the coast to the south-west of the town stretches a range of low hills, called the bluffs, on which the principal inhabitants live.

These neat English looking houses are surrounded by well kept gardens, adorned with many tinted azalias, camellias, and other Japan or European plants and flowers. In the public garden at Yokohama many experiments have been made with the cultivation of exotic trees, and I noticed a large nursery bed of deodar, also others planted out, all of which seem to be thriving.

From Yokohama we proceeded to Tokio, the new capital of Japan, the railway running through a highly cultivated piece of country bordering on the sea, with many orchards and low hills all well clothed with pine and bamboo forest or plantations. A large river is crossed "en route" by means of a fine iron bridge, down whose stream a large number of rafts of pine timber are continually passing from certain forests situated in the hills above. These rafts are constructed about 150 feet long and 15 or 20 feet wide, and contain several hundred logs and poles of various dimensions.

The city of Tokio covers an area of about 70 square miles, and was for a long time popularly supposed to contain more inhabitants than London, but this has been found to be a delusion, the total population, according to the latest census, probably not exceeding 1¼ millions.

The general appearance of Tokio is somewhat disappointing to the traveller who has visited Kioto, the houses being generally low and unassuming, but there are several fine public buildings, also one fine street or boulevard called the Shimbashi.

Lines of trees are being planted along the sides of this boulevard, and I noticed a large pine about 50 feet high and 6 or 7 feet in girth with roots complete, being transplanted by means of a truck drawn by eight strong oxen. Tokio is famous for the number and extent of its public parks, which are generally situated on rising ground, the principal of which are Shiba Ueno, and the grounds of the Makado's palace.

At the first of these, embosomed in a fine grove of *Cryptomeria japonica* trees, may be seen the tombs of several of the

Shoguns or Tykoons of Japan, together with several fine temples elaborately carved and lacquered, the avenues leading to the shrines being lined with rows of large stone or bronze lanterns of fantastic shapes.

Through the kindness of the British Minister at Tokio, I obtained a letter of introduction to Mr. Marimosa Cakie, Chief Commissioner of the Department of Agriculture and Commerce, also "Chef de l'administration des forêts du Japan," who I found most civil and obliging in giving me information regarding the forests of that country. Amongst various other matters which formed the subject of our conversation, I was agreeably surprised to learn that a College of Forestry was started about four years ago at Tokio, which establishment we proceeded to inspect, and a description of which I shall now endeavour to give.

The College is situated in what appeared to be the suburbs of Tokio, and consists of 10 or 12 separate buildings, which comprise lecture halls, museum, professor and students' quarters, cook houses, &c.

The Director, Mr. Matgumo Hazama, appears to be an intelligent man, and he took great pleasure in showing us round and explaining everything. He has visited various Forest Schools in Germany and studied forestry there, so that as a matter of course, the Japan Forest College has been established on what may be called German principles.

The establishment consists of 10 Professors, and there were about 130 students attending the College at the time of my visit. The course as at present arranged extends over 5 years, 3½ being devoted to instruction at the College, including holidays, and 1½ years to practical work in the forest. The age at which the students enter the College is 18 years, and the successful candidates at the final examination are eligible for posts of 25 Dollars, or about Rs. 55 per month, in the Japanese State Forest Department, which is now in course of organization.

The buildings in connection with the College consist of timber and bamboo structures with shingle or iron roofs, and everything appeared to be neatly arranged, clean and suitable.

There are eight class rooms devoted to lectures on forestry, mathematics, natural sciences, chemistry, surveying, &c., together with an extensive laboratory for the chemical analysis of soils. All instruction is of course conducted in Japanese, but the figures used for all calculations are English.

The students live in separate quarters in the same compound, four men occupying each room, some of which I examined and found them neat, clean, and serviceable. All the students dine together in a large hall provided with long tables and chairs, and are charged 5 Dollars, or about Rs. 11 per month, for board and lodging. They are not allowed to leave the premises without a pass, but I observed four small reception rooms with

kitchens attached, where the students can see their friends and entertain them if they choose.

There is a very fair museum attached to the College, which contains a fine collection of about 200 Japanese woods, and above each section, I noticed a neatly framed and glazed complete botanical specimen of the species. There is also a good collection of seeds and forest products of all kinds, including manufactured articles, such as clogs, tubs, large vats, &c.

A zoological collection has also been commenced, and a few of the Japanese animals, birds, beetles, butterflies and other insects have been got together. The homely sheep is considered such a rare animal in Japan, that it finds a prominent place in most museums.

Amongst various curious and interesting objects I was shown a large and well made model of the Kissu reserved forest, which is situated about 100 miles north-east of Tokio, and as far as I could learn, it appears to be the principal State forest at present being worked in Japan. A series of well executed pictures of forest lumbering works at this reserve, and in the forests of the great northern island of Japan near Hakodadi were also exhibited, from which I formed a very favourable opinion of the expertness and skill of the Japanese as lumbermen.

The Kissu forest is stated to comprise an area of 35,000 acres, and consists principally of Hinoki or (*Chamæcyparis obtusa* and *pisifera*), and from the pictures above referred to and the explanations furnished by the Director, it apparently contained trees of very large dimensions, probably as much as 18 or 20 feet in girth. These pictures represent the felling of immense pines by means of the saw, axe, or by fire, in some cases the tops and side branches having been removed, and the fall directed by means of three or four stout hawsers attached to rough capstans.

Other plates showed trees being felled on rocky ground, a thick bed or platform of branches being constructed in order to break the fall as much as possible. The squaring, sawing and transporting of logs 30 or 40 feet long and 2 × 2 feet square, by means of elaborately constructed timber slides, was also represented, the ground as shown in the pictures being of the roughest nature.

The floating of timber down mountain torrents was well illustrated, and several kinds of dams, sluices, and other contrivances common in Germany were also shown, and which I understood the Director to say had been in use for many years in the State forests of Japan. Other plates represented the lowering of logs by means of pulleys and capstans over precipices, also sliding timber down steep slopes in the snow, the front part of the logs being supported on small sledges, and the back end being left as a drag. At the point where the mountain streams "débouche" on the plains a serviceable boom is employed to catch the timber, which is well represented in the

plates, and I could not help observing that the place and general arrangement very much resembled those at Dakh Pathar on the Jumna. By means of this boom the logs are directed into a bay surrounded by piles, where they are kept afloat till it is convenient to raft them down the Tenrin-gawa river to the sea coast. Mr. Marimosa Cakie was most anxious that I should visit the Kissu forest and see all those interesting works for myself, but as the trip would have occupied 8 or 9 days, the time at my disposal did not permit my doing so. No regular system of felling seems to have been followed till lately at this forest, and all the best timber is said to have been removed.

The total area of Government forest in Japan at present reserved, is stated to be only about 3,000 square miles, but no very reliable information on this subject, nor on the question of revenue or expenditure, was forthcoming, nor have the reserves been yet demarcated.

Certain laws and regulations regarding forest conservancy, and especially with regard to the protection of game exist, and it is satisfactory to learn that fire protection is considered so important, that a special clause prohibiting the lighting or carrying fire in all forests is entered on the passports with which travellers have to be furnished whilst travelling in Japan. After several days spent at Tokio we started for the famous shrines of Nikko, situated about 90 miles to the north.

The first part of the journey was performed by train to a place called Utsumaya, the line passing through an undulating and highly cultivated country, all the low hills and considerable portion of the plains land being covered with patches of pine (*Cryptomeria japonica*) and bamboo forests and plantations.

These patches of woodland, the areas of which vary from 5 to 50 acres, and which probably belong to temples, villages and private individuals, are apparently well looked after, and all rank undergrowth and refuse wood removed.

The importance of growing timber and fuel is thoroughly understood and acted up to by the people of Japan, and all waste patches of land in the vicinity of villages are invariably planted up. As a rule, all trees are planted close, so that no pruning is wanted, and clear felling for the coniferous trees, and coppice for the hardwood species seems to be the system in force. As regards the treatment of bamboos in Japan, I never observed any growing in clumps, all stems being invariably situated not less than 2 or 3 feet apart, and distributed in a most regular manner over the whole area.

All kinds of forest produce are thoroughly appreciated in Japan, and the best means of growing the materials most useful for the general public is well understood. It must, however, be admitted that on account of the comparatively mild climate, favourable soil, absence of grazing and plentiful rainfall, distributed over nearly all the months of the year, the planting and rearing

of trees in Japan is a very simple matter, in comparison with the difficulties to be contended with in India.

From the end of the railway to Nikko, distant 22 miles, the journey was performed by means of native carriage, the road being lined the whole way by magnificent avenues of *Cryptomeria japonica* and *Pinus Thunbergii.* These trees are ranged in stately rows on each side of the road, the average girth being about 12 feet, height about 120 feet, and the total number of trees per mile is probably not less than 1,000.

These trees are said to have been planted about 250 years ago by a devotee, who being unable through poverty to add to the shrines at Nikko, decided to show his veneration for the great Shoguns buried there by planting this avenue, and if the tale is true, he certainly could not have left a more conspicuous and lasting memorial.

At Nikko we put up at a native tea house or inn, there being no European hotel there. These houses, which are extremely common throughout Japan, are generally two storied edifices constructed of wood with shingle roofs, the interior being divided up into small rooms by means of sliding screens composed of wood and oiled paper. By the removal of these screens, which is easily effected, rooms of larger dimensions are made at pleasure. All the floors are covered with well made soft mats, the whole of the premises, including the kitchen, being kept scrupulously clean.

The wants of the traveller are promptly and cheerfully attended to by polite waitresses, who are always neat, civil and obliging. There are no bedsteads in these houses, but by the aid of numerous thick rugs, which are kept in stock, the tired traveller finds the floor quite soft enough.

Every tea house has of course its trimly kept garden attached, where one generally sees a fish pond, a waterfall, a rustic bridge with miniature paths, the trees and shrubs being trimmed and often dwarfed so as to suit the surroundings. In fact some of these gardens are arranged on such small proportions as to give the effect of an extensive park viewed from a distance through the large end of a telescope.

The temples or shrines of Nikko, which are dedicated to the memory of two of the greatest Tykoons or Shoguns of Japan who are buried there, are situated in the middle of a magnificent *Cryptomeria japonica* grove occupying several small hills and valleys, the total area of the forest being about 300 acres. The average girth of these trees is about 12 feet, but one tree observed measured over 24 feet in circumference. The height of the trees is about 125 feet, and as far as I could ascertain from the examination of a few stumps, their age appears to be about 500 years.

There is no young growth of *Cryptomeria japonica* in this grove, nor did I observe any natural reproduction of this species

anywhere in Japan. There are in all at this place 29 temples, pagodas and other buildings connected with the shrines of the two Tykoons who are buried on the tops of two of the small hills. These temples are constructed of timber after the most fantastic and artistic designs, and all are elaborately guilt and lacquered all colors of the rainbow, so to speak. They are also decorated with fine carving and bronze work of the most curious description, and at every corner one encounters red, blue, yellow and green demons of gigantic proportions and ferocious aspect.

There is a Japanese saying, which is to the effect, that until the traveller has seen the temples of Nikko he is not entitled to use the word Kikko, which in Japanese means beautiful or splendid, and it must be confessed that although we saw these temples and shrines under the somewhat depressing influence of a Scotch mist, we agree that the praises bestowed on this charming spot by all who have visited it, are by no means exaggerated.

After having thoroughly examined Nikko and its vicinity, we started for the lake of Chiwzinji, situated 10 miles further up the mountain at about 4,000 above sea level. The road up leads through several extensive forests of oak, elm and maples interpersed with numerous clumps of *Pinus parvifolia* and other conifers.

At about 3,500 feet elevation a number of beeches and birch trees were encountered, some of the latter being about 8 feet in girth. Amongst other shrubs the azalias were particularly conspicuous, and hundreds of acres of the hill sides were tinged pink by a species which was in flower at the time of our visit.

The road up is a well constructed 6 foot path, the mountain torrents being spanned at intervals by well constructed rustic bridges, and several waterfalls are passed, some of which are of considerable height.

The lake of Chiwzinji is about 12 miles long by 2 miles broad, and has probably at one time formed the crater of a volcano, lava and ashes being everywhere met with on its banks.

The lake is dominated by a volcanic cone called Chirani, which attains an altitude of 8,000 feet, and was in active eruption as late as 1870.

The scenery of the lake even at the end of April had rather a wintery appearance, the trees being still leafless, and wreaths of snow were lying about in the forest at the time of our visit. We put up at a tea house situated on the edge of the lake, which we found somewhat cold, and more suited for summer than for spring weather.

Early next morning we crossed a low pass and walked down a rough forest path about 12 miles to a place called Ashimo, where our Jinrikshaws were awaiting us.

At this place there is a large copper smelting furnace, in connection with the fuel supply to which extensive forest operations were being carried on in the neighbouring hills through which our path lay. These consisted principally in the preparation of large quantities of charcoal, which was being manufactured in large kilns of the following description.

The kilns are made of rough masonry about 6′ × 6′ inside measurement, and are vaulted over a small door, about 5½′ × 2′ being left.

The billets of hard wood are cut about 5 feet long, and if the logs are more than 9 inches in diameter they are split in half. These were carried through the doors by the charcoal burners, and closely packed on end, a certain quantity of inflammable material, such as leaves and branches, being added. The door is then built up, two small openings for air being left, and after 24 hours baking the charcoal is raked out and extinguished by pouring on water, a plentiful supply being of course required for this mode of manufacture.

The charcoal is removed from the kilns on coolies backs, who carry immense loads, and is taken to a depôt lower down, where it is stored in large thatched godowns, from whence it is transported in two wheeled hand carts to the furnace situated about 3 miles lower down the valley.

Large quantities of fuel were also being cut and stacked, the billets being all sawn into 2 feet lengths. The fuel after being measured up was being floated down the mountain stream, which had evidently been prepared for the purpose to a point situated about half a mile above the factory, where it is caught by means of a large dam. It is then transported along a canal, which in addition to floating the fuel, also turns an immense water wheel which drives the machinery used for crushing the copper ore.

Large quantities of the manufactured copper prepared at this factory is exported to India, and a limited quantity even reaches London. The forest where the fuel operations for the supply of this furnace were in progress is said to be the property of the State, and is leased by the owners of the foundry, and as might be expected, the fellings were being conducted in a very unsatisfactory manner, whole hill sides being swept bare, also traces of fire were everywhere apparent. I was informed that the intention of the Government is to plant up the whole area with *Cryptomeria japonica*, but owing to the denuded nature of the ground the operation, even under the favourable Japanese conditions, will not be an easy one.

The next day on our way to Haigo, which is the nearest railway station, we passed through many flourishing villages, in the neighbourhood of which we observed numerous plantations of *Cryptomeria japonica*, oaks and other hardwood trees.

The plants necessary for these operations are obtained from well kept nurseries, one or two of which I noticed in the neigh-

bourhood of most villages. Tree plants are also regularly sold in the bazaars, where one sees them offered for sale tied up in neat bundles containing 25 to 50 plants according to their size. Besides trees, flowers in pots are largely sold in the bazaars, the Japanese being thorough appreciators of the beautiful. One also sees curious dwarfed plants offered for sale, and a pine or *Cryptomeria* and an oak 15 to 20 years old, may be obtained in a box measuring a few inches square.

In passing through these villages I was agreeably surprised to notice that the packs of useless dogs, which as a rule infest all Indian villages, were conspicuous by their absence in Japan, and only well regulated dogs, provided with collars, on which the names of the owners are inscribed, are apparently allowed.

This portion of Japan is a great silk producing district, and numerous plantations of mulberry trees were observed. These are generally treated on the pollard system, the trees not exceeding 5 feet in height, and all are carefully looked after and well manured. On approaching Haigo, we crossed the river Tanie Gawa by means of a well constructed bridge of boats, and observed a number of natives busily employed catching fish after various methods. Some were engaged dragging nets and driving the fish into elaborately constructed traps, in the making of which the Japanese are very expert, whilst others were engaged fishing with rod and fly after quite a civilized fashion.

At Haigo we took the train and returned about 80 miles to Yokohama, much pleased with our trip which occupied us about six days.

The next excursion was to Myenosta, a small hill station much resorted to by the inhabitants of Japan on account of its mineral waters. It is situated about 52 miles west of Yokohama, and not far from the famous sacred mountain of Japan called Fujiyama.

The first part of the journey was performed by carriage, the Tokaido or grand imperial high road of Japan having been followed as far as Yumeto, situated at the foot of the hills. From this point we walked up a distance of about 5 miles to Myenosta, the road and scenery very much resembling that between Rajpur to Mussoorie. Myenosta and its vicinity is essentially volcanic, there being many hot sulphur springs all over the neighbouring hills, which are highly appreciated for bathing purposes, the water being led into the bath houses by means of bamboo pipes.

The active nature of the volcanic action of this neighbourhood made itself felt on the night of our arrival by a sharp shock of earthquake, which rather alarmed some of the travellers.

The next day we visited the lake of Hakoni 9 miles distant, and situated in the middle of picturesque hills, on the top of one of which the Makado has constructed a new summer residence after the style of a French château.

In the neighbourhood of this palace extensive areas were being cleared of inferior kinds of jungle, and the planting of *Cryptomeria japonica* was in progress.

The cane brakes on the higher portions of the hills were also blazing on the occasion of our visit, with the object it was said of inducing a young growth of pasture to spring up, but apparently the grass of these hills forms very indifferent nutriment for cattle, and is absolutely fatal to sheep as already explained in the former part of this article.

The surplus water of this lake is carried through a hill of considerable breadth by means of a tunnel, and utilized for irrigating the rice fields of 17 villages situated far down the neighbouring valley. After enjoying the scenery at the south end of the lake for a while, we proceeded by boat to the upper end distant 9 miles, and then walked over the pass of Ajigoku, the meaning of which in Japanese is big hell. At this pass we found the whole hill side honey-comed by sulphur springs, many of which were boiling up on all sides and giving off clouds of vapour and sulphur fumes.

En route back to Myenosta we passed through a small patch of forest, where I observed a considerable number of box wood trees, most of which were, however, of small dimensions. The next morning I ascended a hill situated to the west of Myenosta, and obtained a magnificent view of Fujiyama, the snow-capped sacred mountain of Japan. This mountain is of volcanic origin, and it is said to have been extinct since 1707, when the last eruption apparently took place. It is about 15,000 feet elevation, and it may be seen during fine weather whilst 100 miles out to sea, towering above the clouds. Fujiyama is a great place of pilgrimage for the Japanese, but at the time of my visit the ascension could not be made on account of the deep snow, the path not being open till the end of June.

From Myenosta we returned to Yokohama *viâ* Enoshima, a small romantic island much resorted to by the inhabitants of Yokohama. At this place there is a fine cave 140 yards long and 10 yards high, much resembling Fingal's cave on the coast of Scotland, and which is much visited by pilgrims.

There are numerous Buddhist temples on the island, but the peculiarity of this place are the aquatic curios offered for sale, and which consist of coral and sea shells, and endless other articles manufactured from them. Here also may be obtained specimens of a curious glassy sponge, which the divers bring up from deep water, also immense crabs, some of which reach the astonishing dimensions of 16 feet between the extremities of the outstretched claws.

On the way back to Yokohama, distant about 18 miles, I visited a famous Buddha image called the Dai-Butsu.

This colossal statue is made of bronze and is 50 feet high, the length of the face being $6\frac{1}{2}$ feet and mouth 3 feet wide.

Some idea may be formed of the degree of civilization to which the Japanese have attained by the fact, that a photographer has established his studio close to the Dai-Butsu, so that travellers can have themselves taken picturesquely distributed over various parts of Buddha's body or sitting on his thumbs.

In concluding this article it may interest intended visitors to know that the best seasons for visiting Japan are apparently from the middle of April to the end of May, and again from the middle of September to the end of October. During June, July and August the traveller's movements are said to be a good deal hampered by rain, and besides at that season fleas and mosquitoes are particularly troublesome, whereas during the time of my visit, *viz.*, from the middle of April to the middle of May, these pests were not noticeable.

As regards the cost of a visit to Japan, it may be stated that it is by no means a cheap country, actual travelling expenses at all events being about twice as high as in India. As regards other charges, they are as a rule also high, and in fact generally speaking the Yen or Dollar, equal to about 4 shillings, may be said to have about the same commercial value as the Rupee in India.

On the 15th of May I embarked on board the good ship "City of Sydney" for San Francisco, after a sojourn of about a month in Japan, very well satisfied with my visit to the *"land of the rising sun."*

E. McA. M.

SUGGESTIONS FOR A MORE ECONOMICAL UTILIZATION OF COW-DUNG AND RAB IN THE BOMBAY PRESIDENCY.

READERS of the "Forester" are aware that a Commission was appointed several months ago to enquire into the alleged forest rights of inhabitants of certain villages in the Thána and neighbouring districts.

Of the matters to be investigated, not the least important one concerns the right to *Ráb*, and the means of providing either a substitute for it, or a sufficient supply without causing serious injury to the forests which are necessary to protect the hill-slopes.

Ráb may be defined as any forest produce of a vegetable nature used for manuring fields. It is used in the Konkan chiefly for manuring nurseries for rice-seedlings. For this purpose, loppings of trees, with or without cow-dung, are burnt: seed is sown in the ashes: and the seedlings which came up are ultimately planted out in the fields.

The present agitation in regard to this matter appears to be mainly owing to the fact that the forest originally given out for ráb material is no longer sufficient to produce a continuous and sufficient supply. This failure may be partly owing to the extension of cultivation, but it is also in a great measure owing to the exhaustion of the ráb forests, and the question naturally arises as to the possibility of employing substitutes for forest ráb, or of employing the materials used for manure more economically.

It seems to me that the method of preparing and burning the manure, which obtains in the Konkan, must lead to a vast amount of waste, and to a diminution of important chemical and physical activities in the soil. It also appears probable that these obstacles to a rational system of agriculture might be overcome by adopting more economical methods in preparing and applying the manure. Even when manure is not burnt, it is seldom, if ever, properly prepared or applied, and there can be little doubt that the manurial properties even of unburnt ráb and cow-dung might be considerably enhanced by a more judicious use of the materials available.

Let us consider what the effect of burning is. In the first place, all the moisture and organic matter of the manure are dissipated in the process. In this organic matter, it is chiefly the nitrogen that is important as nutriment, because it cannot be replaced except by means of artificial manures, or by precipitation from the atmosphere. The dissipation of nitrogen is, therefore, no doubt a serious loss to the crop. Large quantities of carbonic acid are also lost, but, as this gas is decomposed by the leaves, and is always contained in sufficient quantities in the air, its loss is certainly of much less importance to crops than that of nitrogen, viewing it purely in the light of plant-food. This admission does not, however, by any means imply that an additional source of carbonic acid is to be despised even as a means of nutriment; on the contrary, it is reasonable to suppose that an abundance of carbon would directly stimulate vegetation.

At the same time, the most useful function of this acid is undoubtedly its action as a solvent of other nutritive substances in the soil, and so highly does Wolff value it in this respect, that he considers no natural land could afford agricultural crops, a sufficiency of phosphates and carbonates without the presence of free carbonic acid in the soil.

In the second place, burning has the effect of diminishing the absorptive power of soils for nutritive substances, notably ammonia, phosphoric acid and potash, because soils containing a proper supply of organic matter are able to retain a much larger quantity of these substances than soils which are devoid of organic matter. There is, therefore, in the former case, less fear of nutriment being washed out or of its escaping in a volatile form.

A third objection to burning is that the physical properties of the soil are not improved, whereas, if manure be applied unburnt, the soil is improved physically by the organic matter, which in decomposing turns to a soft friable mould peculiarly suitable to the growth of plants, and which is considered of such importance, that the fertility of soils have often been gauged by the quantity of humus they contained.

I think I have said sufficient to convince the most obstinate cultivator, if he is open to conviction, that the burning of manure entails loss of nutriment, and that it diminishes in soils highly useful physical and chemical properties which certainly cannot be measured numerically, but which every practical farmer and forester know how to appreciate. All this is doubtless already known to the readers of this Journal, and I should not have dwelt at such length on the importance of not burning manure, had not a high authority on agriculture expressed his opinion that the methods employed by ráb cultivators in utilizing the materials at their command are the most economical and remunerative.

In all countries, agriculturists have been extremely tardy in deriving benefit from an increased knowledge of the nature of things, and Indian farmers are apparently no exception to this rule. But they are not all as unthinking as the average Thána ryot appears to be, or at all events he who lives in the forest tracts. A goodly number, perhaps a majority, do not burn their manure, and as a bright example of this genus, I may cite a friend of mine who is a large landholder in the ghát-tracts of this district. He tells me that formerly he used to burn his manure for rice-land, but that he has discontinued the practice because he finds that better returns are realized from *kucha* manure. Although the practice of using unburnt manure is common enough in this district, I must confess that I was agreeably surprised to learn that my friend had actually overcome this prejudice of custom, and changed to a system which indicates a decided advance, and leads one to hope that others may follow his example if they see the way clearly to benefiting themselves. It also strengthens my belief that the burning system is merely a bad habit. Fifty years ago, the forests in the neighbourhood of Bombay were considered of little or no value except for the teak and one or two other timber trees they contained, and people were free to take as much inferior wood for ráb burning as they liked. They have, therefore, become thoroughly habituated to their wasteful ways, and, although the forests are becoming exhausted, they are naturally unwilling to abandon what they consider to be a method essential to the making of their crops. In this prejudice, if it be merely a prejudice—and there is not a particle of evidence to show that it is anything else—they have a powerful supporter in the Director of Agriculture, who not only considers forest ráb ne-

cessary for their welfare—which may, or may not, be the case—but also that burning it is the best way of utilizing it as manure. For my own part, I can see no reason why—if kucha manure succeeds in a tract quite similar as regards climate and situation to another tract in which a different system prevails—the kucha system should not do equally well in both tracts. Nor does there appear to be any reason why grass should not be as efficacious as spray wherever a sufficient quantity of cow-dung is available.

Owing to the pernicious custom of allowing cattle to graze all day long in the forests, and to the apathy of cultivators in preparing, preserving and applying manure, there is a dearth of farm-yard manure in most ráb villages, but I believe that, if the simplest precautions were taken, a much greater quantity might be made available for the fields. For lands to which kucha manure is applied in this district, the manure is collected in pits and carried to the fields once a year. Great loss must be caused by allowing manure to lie so long unused, because nothing is done to prevent the escape of volatile or liquid ingredients by spreading layers of earth, lime, &c., from time to time over the manure, and by making pits impervious to liquids ; nor is anything done to keep the manure moist and prevent too rapid decomposition. If these precautions were taken, and the manure put out on the land as soon as possible, the result would be a considerable improvement in the quantity and quality of the manure available for his crops. Experiments with pit manure, carried out at Pommeritz during the winter months, show, for instance, that in 12 weeks over 25 per cent. of dry matter were lost. It is not likely that cultivators will go to the trouble and expense of constructing suitable, impervious manure pits, nor that they will collect cattle urine to sprinkle over the manure, nor that they will ever simply water it ; but it would give them no more trouble to put the manure on to their fields early in the season instead of late, although it would certainly be a less convenient season for the purpose, owing to the harvest operations being then in full swing. Rice fields are generally ploughed up immediately after the crop is taken off the ground in November—December, and all available manure at that season might be applied then, and ploughed under at the same time, instead of being allowed to run to waste in pits until the end of May. There is, I believe, a prejudice against ploughing in, but, of course, the more intimately the manure is mixed with the soil, the less probability is there of losing useful ingredients, and the more lasting it is in its effects as compared with manure simply spread over the surface although the immediate effects may be inferior. Where straw is not available for mixing with the cow-dung, grass (which is procurable in large quantities in all hill tracts) would probably be more useful than any other kind of forest ráb, as it absorbs moisture much more readily than

spray, and it is quite possible that, if the prejudice in favour of leaf ráb could be overcome, grass would prove a satisfactory substitute, for the chief use of ráb when mixed with cow-dung which is not to be burnt is to sop up the liquid part of the manure.

There can be no doubt that the system of sending cattle to graze all day long in the jungles is a serious obstacle to agricultural reform. *It is much better to have a few home-fed animals* than a large and badly-fed stock that spends all its days in the jungle. The custom is, however, an old established one, and, as such, is not likely to be abolished in a hurry. But, if no reform can be effected in this respect, some improvement might certainly be brought about in the stalls, or pens, in which cattle are kept, when they return from the jungles for the night. Sometimes litter is put down, but, in most cases, the cattle stand on the bare ground, and the liquid manure is all lost. If litter, consisting of grass, straw or spray, were put down, *much of this—the most valuable—constituent of good manure* would be saved. Properly constructed stalls made so as to completely prevent loss of liquid matter by percolation, are of course greatly to be desired, but are scarcely to be expected from the ordinary cultivator.

I am informed that it is customary in Thána to lop the same trees every year. If this is really the case, it may be safely predicted from what is known of the effects of ráb in Europe, that no forest can stand the drain, and that even if the area set apart for providing ráb were four times as great as that required, *in the present state of the forests, to produce one year's* supply, it would be very doubtful if the devastation of rábed areas could be asserted. Any measures, therefore, that appear likely to diminish the drain on the forests deserve the serious attention of all who are interested in the welfare of the race of ráb cultivators: the sooner the ryot learns to economize his materials, the longer will the ráb supply last, and the better will be his position to meet the day when the inevitable collapse must open his eyes to the real nature of things.

L. M. G.

THREE MONTHS' PRIVILEGE LEAVE TO NEW ZEALAND.

THANKS to the rivalries of the present excellent steam navigation companies the communications of the world are yearly improving, perhaps in no case more so than in that of Australasia. A three months' trip from India to New Zealand and back, which could not have been attempted a few years ago, can now be done with ease, giving the traveller time to take a rapid glance at the principal towns and main features of the country.

Starting from Dehra Dún on the 5th of July the following itinerary shows how my three months were spent :—

Left Dehra Dún,	July	5th.
Arrived Bombay,	,,	8th.
Left ,,	,,	10th, by P. O., S. S. "Mirzapore."
Arrived Colombo,	,,	13th.
Left ,,	,,	14th, by P. O., S. S. "Clyde."
Arrived King George's Sound,	,,	25th.
Left ,, ,, ,,	,,	26th.
Arrived Glenelg,	,,	29th, went to Adelaide and back, by rail.
Left ,,	,,	,,
Arrived Melbourne,	,,	31st.
Left ,,	August	3rd.
Arrived Sydney,	,,	5th.
Left ,,	,,	,, by Union Co. S. S. "Tarawera"
Arrived Auckland,	,,	10th. Put up at the Star Hotel.
Went to Helensville,	,,	11th, by rail to see Kauri pine forest.
Returned to Auckland,	,,	12th, by rail.
Left Auckland and arrived Oxford,	,,	13th, ,,
Left Oxford and arrived Ohinemutu,	,,	14th, by coach, 33 miles.
Went to Rotomahana and back,	,,	16th, 40 miles on horseback to look at the new volcano.
Left Ohinemutu, arrived Taupo	,,	18th, by coach, 60 miles.
Left Taupo, arrived Tarawera,	,,	19th, ,, 50 ,,
Left Tarawera, arrived Napier,	,,	20th, ,, 50 ,,
Left Napier,	,,	21st, by Union Co. S. S. "Manapouri."
Arrived Wellington,	,,	22nd.
Left ,,	,,	23rd.
Arrived Christchurch,	,,	24th, left S. S. "Manapouri" at Lyttleton and went by rail, 9 miles, to Christchurch.
Christchurch to Dunedín,	,,	25th, by rail.
Left Dunedin,	,,	26th, by rail to Pt. Chalmers rejoining the "Manapouri."
Arrived at the Bluff,	,,	27th.
Arrived Hobart,	,,	30th.
Arrived Melbourne,	September	2nd.
Left ,,	,,	7th, by P. O., S. S. "Sutlej."
Arrived Glenelg,	,,	9th, went to Adelaide and back, by rail.
Left ,,	,,	,,
Arrived King George's Sound,	,,	13th, spent the afternoon in Albany.
Left ,, ,, ,,	,,	,,
Arrived Colombo,	,,	25th, spent the day on shore.
Left ,,	,,	,,
Arrived Bombay,	,,	29th.
Arrived Poona,	,,	30th.

Returned to Bombay,	October 1st.
Left Bombay,	,, 2nd.
Arrived Dehra,	,, 5th.

The actual cost of travelling, exclusive of the journey to and from Dehra, was as follows:—

	Rs.	A.	P.
Bombay to Sydney and back, by P. and O. steamers,	600	0	0
	£	s.	d.
Sydney to Auckland, by Union Co's. Steamer, ...	10	0	0
Auckland to Helensville and back, by rail, ...	0	10	0
Auckland to Oxford, by rail, ...	1	7	9
Oxford to Ohinemutu, by coach, ...	1	5	0
Ohinemutu to Rotomahana and back, horse and guide,	3	0	0
Ohinemutu to Napier, by coach, ...	4	5	0
Napier to Melbourne, by Steamer, ...	13	0	0
Lyttleton to Christchurch and Dunedin, by rail, ...	1	11	7
Glenelg to Adelaide and back by rail on two occasions,	0	8	8
Steam launch at Albany, ...	0	2	0
Total, ...	35	10	0

It will be seen from the above that a little over a fortnight was spent in and about New Zealand. The steamers of the Union S. S. Company leave Sydney weekly for New Zealand, *viâ* Auckland and East Coast ports, calling at Hobart every alternate trip on their way to Melbourne, and there is a similar service from Melbourne to New Zealand and Sydney.

People who are fond of town life and do not care for rough travelling had better not make this Australian trip. The towns are undoubtedly fine and in many respects improvements on English ones of the same size; yet there is an appearance of newness about them, which, though indicative of progress, is not pleasing to the ordinary traveller. The streets are not well kept as a rule, and most of the towns are badly lit, whilst the larrikin element of the population is somewhat too prominent. *New Zealand contains numerous excellent* harbors well distributed along its extended coast line of nearly 3,000 miles, and at these favorable spots little towns, containing usually a population of from 10,000 to 50,000, have sprung up; such are Auckland, Napier, Wellington, New Plymouth, Christchurch and Dunedin. But as I wish to describe some of the natural features of the country rather than its towns, I will pass over the latter, only remarking that as an example of colonial ambition all the towns are called "cities" and all the inns "hotels."

New Zealand is situated about 1,200 miles south-east of Australia, and is very nearly the antipodes of the British Isles, to which it is almost equal in area. It is in many parts very

mountainous, its most striking and important physical feature being an extensive longitudinal mountain range, which, interrupted by Cook Strait, runs through the whole length of the two larger islands from the South Cape to the East Cape. This range, consisting of up-heaved zones of stratified and massive rocks of different ages, constitutes the powerful backbone of the colony; it is most prominent in the Southern Island, where it forms the Southern Alps, many of whose heights are covered with perpetual snow, the loftiest peak being Mount Cook in the province of Canterbury, which rises to 12,349 feet above sea level. The limit of arboreal vegetation on these mountains varies between 4,000 and 4,500 feet.

Of the plains, those of Canterbury are the most extensive, whilst lakes are numerous, there being two distinct lake districts, *viz.*, that of the Hot Lakes in the North Island and that of the Cold Lakes in the South Island. The largest are Lake Taupo, with an area of 200 square miles, and lakes Te Anan and Wakatipu covering respectively 132 and 114 square miles.

The North Island is essentially volcanic, a fact of which the recent eruptions have more vividly than pleasantly reminded the colonists. There are some primary rocks, and the carboniferous deposit is strongly marked in the Bay of Islands. The South Island is mainly sedimentary, whilst its ranges are of slate and granite, with silurian sandstones and limestones.

The climate, as a whole, is agreeable, but varies considerably in different parts of the colony. The changes of weather and temperature are very sudden, and there is no uniformly wet or dry season in the year, although the greatest quantity of rain falls in the winter; January and February are the warmest months, June and July the coldest. The mean temperature is 55°, varying from a mean of 44·90° in the winter, to 65·4° in the summer. The average annual rainfall is about 45 inches, that of the South Island being much less than that of the North Island, *viz.*, 39 and 51 inches respectively.

The whole of the colony is noted for its breezes and frequent gales, of which there are generally over 100 in the course of the twelve months. As a protective measure, most homesteads have small belts of trees planted to the windward, mostly of the rapid-growing Californian pine (*P. insignis*), but sometimes of Australian Eucalypts and Acacias.

The first thing that strikes the new comer is the enormous influence which European settlers have had in modifying the ancient fauna and flora of the islands. It is not yet 120 years since Capt. Cook first landed on these shores. Since that time, however, the face of the country has changed more than Cook could have conceived possible in his wildest dreams of colonization and settlement. The formidable native population which swarmed along the shores, wherever he attempted a landing, has dwindled down to a comparatively insignificant remnant of

44,000, whilst the white population, which has displaced the natives, numbers about half a million. Except in the untravelled fastnesses of the country, there is no considerable area of agricultural or pastoral land that has not its fields of corn or its thousands of cattle and sheep. Stations, farm-steads, townships and cities have sprung up, where, in the beginning of the century, nothing was to be seen but endless tracks of tussock, fern, swamp-land or stretches of trackless bush.

The only indigenous mammalia are the native dog, the rat and two species of bat. None of the marsupial tribe peculiar to the Australian continent are to be found, whilst as regards reptiles New Zealand must have been blessed by St. Patrick, for there are no snakes and only a few harmless lizards. In years past the moa, that gigantic wingless bird of the ostrich tribe, must have been common, but its extinction took place before the islands were visited by Europeans. These birds still existed, however, in great numbers, when the first Maori colonists arrived, but they were most stupid and sluggish, and were destroyed wholesale by setting the grass or scrub on fire, when they would quietly allow themselves to be roasted alive. The natives killed in this way vast numbers, more than they could use or even could find, when the fire spread to great distances. Thus, we have here a remarkable instance of the complete extermination not of a tree or shrub, but of a bird, by jungle fires, which as we shall see further on have also considerably modified the flora.

The museum at Christchurch should be visited, as it contains one of the most complete collection of moas in the world.

Pigs were first introduced by Capt. Cook, and are now wild in most parts of the colony, so that pig-hunting with dogs has become one of the institutions of the country. Since then all kinds of domestic animals have been imported, and all have thriven well, amongst others, unfortunately, the rabbit, which has alas increased but too rapidly and is becoming a serious pest. New Zealand is better off for birds, there being 133 species peculiar to the colony, many of them water-fowl. Perhaps the most remarkable of all is the 'kea,' a species of parrot, which, since the introduction of sheep has developed a new instinct, giving up its vegetarianism, for the pleasure of killing these defenceless animals by the score and feasting on their kidney fat. *This interesting but annoying instinct has induced* some of the run-holders to put a price of 2*s.* 6*d.* on each kea's head.

Domestic birds have been introduced in large numbers, as also game birds, such as pheasants, partridges, quail and grouse, whilst sparrows and larks are now the commonest birds in the country.

With regard to the Flora, Dr. Hooker remarks as follows:—

"The rapidity with which European weeds, and especially the annuals of cultivated ground are being introduced into and disseminated throughout New Zealand is a matter of surprise to all observers, and

not only to professed naturalists. It is a point of very great significance in reference to all inquiries relating to their superior powers of propagating and establishing themselves which the plants and animals of some countries display, as contrasted with those of others; and when, as in the case of New Zealand, the result is the actual displacement and possible extinction of a portion of the native flora by the introduced, the fact may well arouse the interest of the most listless colonist."

Amongst such naturalized plants might be mentioned numerous *Cruciferæ*, *Caryophyllaceæ* and *Gramineæ;* the gorse, clovers and vetches ; sweet-briar and the dog-rose ; the elder ; the daisy, groundsel and dandelion ; the pimpernel ; the plantain, and finally docks and nettles. At the time of my visit, the gorse was in full bloom, forming one of the most conspicuous objects in the landscape, and being particularly abundant in the Canterbury plains, where it is used almost universally for hedging purposes.

The indigenous flora is essentially an insular one of ancient origin, the Cryptogams far out-numbering the Phanerogams, and New Zealand may be regarded as the botanical region of ferns, which are represented by about 130 species, nearly one-third being peculiar to the colony, including many beautiful tree-ferns with trunks from 10 to 40 feet high. The common bracken (*Pteris aquilina*) covers hill-side after hill-side, and is thus very characteristic of New Zealand scenery. The rhizomes of the variety 'esculenta' were formerly roasted and eaten by the natives.

The Lycopods are the largest in the world, and the most closely allied to the fossil Lycopods of the coal period, of any existing plants. Indeed the flora vividly recalls some old geological period, and the analogy is rendered more real by the, in many places, sluggish streams, the numerous marshes and the great abundance of mosses and lichens which thrive so well in the moist temperate climate, covering every rock, stone, tree and fence. Open peaty valleys are also not uncommon, and on Stewart's Island in many instances the duramen of old trees is said to be converted into peat, whilst the alburnum is still discharging its functions. Still more striking is the fact of the dense lower leaves on the stem of *Raoulia goyeni* becoming changed into peat, whilst the upper ones are performing their usual duties.

There are about 1,000 flowering plants, of which two-thirds are peculiar to the islands, one-fifth are Australian, and one-tenth American plants. One of the most curious points about the flora is the paucity of leguminous plants. The *Leguminosæ* abound in Australia, especially the Acacias, but this order is less developed in New Zealand than in any other part of the world, and the genera are often most peculiar, *e. g.*, *Carmichælia*, usually leafless shrubs with small pods, the valves opening at the tip only : this is the native broom of the settlers.

The genus *Pittosporum*, two or three species of which occur in the sub-tropical forests along the base of the Himalayas, is here represented by a dozen species. Amongst other genera or species common to the two localities mentioned are—

Dodonæa viscosa, *Coriaria*, *Rubus*, *Panax*, *Loranthus*, *Myrsine*, *Olea*, *Cuscuta*, *Veronica*, *Vitex*, *Tetranthera*.

The *Coriaria ruscifolia* is very similar in appearance to the common Indian shrub *C. nepalensis*. The genus *Rubus* is represented by a single species, *R. australis*, a lofty climber, armed with scattered prickles, and called by the settlers the 'bush lawyer,' because they invariably suffer from too close an acquaintance with it.

The genus *Panax* is interesting from the fact that in many species the leaves are di- or tri-morphic. Mr. Kirk thus describes *P. crassifolium* in the Transactions of the New Zealand Institute:—

"A small diœcious tree 20—35 feet high; leaves di- or tri-morphic; on young plants up to 15 feet high, simple, linear, rigid, coriaceous, 12—30 inches long, spreading or drooping so that the under surface forms an acute angle with the stem, remotely or sinuately toothed, narrowed into a short, stout petiole, purplish below, brownish-green above, with more or less irregular pale blotches; abruptly passing into tri-foliolate leaves, of which the petioles are about 3 inches, and leaflets 3—6 inches, ultimately succeeded by the mature unifoliolate state, the leaf being lanceolate, oblanceolate or obovate and 3—7 inches long. The benefit which the plant derives from these changes does not appear to be known or even to have been discussed."

New Zealand possesses three genera of *Loranthaceæ* comprising nine or ten species, and Mr. Kirk gives an interesting instance of double parasitism in the case of *Tupeia antarctica* growing on *Loranthus decussatus*, which derived its nourishment from a beech tree *(Fagus solandri)*. The portions of the supporting branch of the *Loranthus* beyond the point of attachment of the *Tupeia* were usually dead or dying, showing that the latter had absorbed a large quantity of the juices necessary for the full supply of the foster parasite.

The order *Myrsineæ* represented by the genus *Myrsine*, advances much farther south in these islands than in any other longitude. There are three species of *Olea* all with apetalous flowers. The genus *Veronica* forms a more conspicuous feature of the vegetation here than in any other country, both from the number, beauty and ubiquity of the species, from so many forming large bushes and from their remarkable forms. Hooker enumerates no less than 40 species.

The order *Verbenaceæ* is represented by four species, the most important being the puriri (*Vitex littoralis*), its wood being in great demand, being extremely hard and almost indestructible under water. There is only a single *Tetranthera*, *T. calicaris*,

and this is confined to the North Island. The tropical orders *Meliaceæ* and *Anacardiaceæ* have also only a species apiece, *Dysoxylum spectabile* and *Corynocarpus lævigata*.

There are scarcely 20 species of *Myrtaceæ*, and the large and important genus *Eucalyptus*, so characteristic of Australia, is entirely absent. The paucity of species is, however, compensated for by the extreme abundance of one of them, *viz.*, *Leptospermum scoparium*, the tea-tree of the settlers, so called because the leaves have been used as tea in Tasmania and Australia ; in fact, the manuka scrub, if we adopt the Maori name, is typical of New Zealand scenery. This species is remarkably prolific, seeding at a very early age, and occurring either as a small bush on poor soils and on low-lying badly-drained ground, or as a small tree 10-40 feet high on hill-sides and on good well-drained soils ; in fact, the condition of the manuka scrub often guides the settler as to the quality of the land he is about to take up. Another prominent myrtaceous plant is the rata, which acts the part of the Indian peepul, killing the tree it embraces.

There are two species of fuchsia, which genus is found nowhere else in the old world. They appear often to form a natural protective belt against fire around forests of rimu and other inflammable conifers, and the Conservator thinks of utilizing this property in the formation of permanent fire-lines.

The large order *Rubiaceæ*, which in the north temperate zone contains only herbaceous species, is here represented by numerous shrubby forms belonging to the genus *Coprosma*, which is especially characteristic of New Zealand ; all the species are diœcious with very small flowers and exserted anthers.

Shrubby *Compositæ* are pretty common, the genus *Olearia* being largely developed both here and in Australia. *Raoulia eximia* is a most singular plant, forming on the mountains large woolly balls 2 feet high, the whole plant being enveloped in the soft velvety, white tomentum. These plants are called 'vegetable sheep,' and an old settler delights to take in a new arrival by pointing to a lot of these plants on a hill-side and asking the uninitiated one to "fetch down them ere flock of sheep."

Pisonia umbellifera, a shrub belonging to the *Nyctagineæ*, is remarkable for its viscid pericarps, the viscid substance acting it is said like bird-lime, so that small birds, such as Silver-eyes (*Zosterops*), sometimes get glued on by their wings.

Most of the *Coniferæ* are important forest trees, and will be mentioned later on ; the species of *Phyllocladus*, or celery-leaved pines, are of special interest to the botanist from their singular foliaceous appendages often resembling ferns ; thus *P. trichomanoides*, a handsome tree 70 feet high, derives its specific name from the resemblance of its leaves to that of species of *Trichomanes*.

There are several characteristic liliaceous plants. *Cordyline* (or *Dracæna*) the palm-lily, is a conspicuous feature in nearly

every New Zealand scene; it is the well-known cabbage palm of the settlers. The large grass-like astelias are common epiphytes on the branches of forest trees, and without them the 'ensemble' of many a New Zealand forest would be incomplete. The New Zealand flax (*Phormium tenax*) belongs to a genus found only, elsewhere, in Norfolk Island. The extraction of the fibre, which is largely used for rope-making, has given rise to an important industry, and the annual value of the exports of phormium, as the fibre is called in commerce, amounts to about £25,000.

There is only one indigenous palm, *Areca sapida*, called Nikau (worthless) by the Maoris, because when they first saw it they mistook it for a common tree of their native land, probably *A. Baueri*, whose young inflorescence they were fond of eating, and bitter was their disappointment when they found nothing edible in the New Zealand species.

To sum up; the plants which help more than any others to give a peculiar character to New Zealand scenery in the open country are the bracken, covering mile after mile, of undulating hills, the cabbage palm scattered here and there amongst the ferns, being particularly common near streams, and the New Zealand flax, which is most abundant in marshes, along the banks of rivers and in damp ravines.

The forests are different from any other forests in the world, rivalling those of Burma in their density, but containing scarcely a living thing, the more or less complete absence of birds and animals being almost appalling to one accustomed to an Indian jungle. There are over 100 indigenous forest trees, the more important being the kauri pine (*Dammara australis*), the totara (*Podocarpus Totara*), the matai or black pine (*P. spicata*), the kahikatea or white pine (*P. dacrydioides*), the rimu or red pine (*D. cupressinum*), and the tanekaha (*Phyllocladus trichomanoides*) all conifers; the puriri (*Vitex littoralis*), hinau (*Elæocarpus dentatus*), rata (*Metrosideros sp.*), rewarewa (*Knightia excelsa*), and four species of beech.

The totara is the most durable of all, and is greatly valued for piles, as it resists the ravages of the 'teredo navalis' better than other timbers. The rimu is a beautiful wood, very suitable for furniture, but rather difficult to work, which makes it expensive. The puriri is extensively used for posts and rails, and of late for railway sleepers. But what first drew to New Zealand the notice of European traders was the supply of excellent spars to be got from the kauri forests of Auckland. Even now no New Zealand wood is of such general use for all kinds of work from shipbuilding to cabinet-making. For the last named purpose a peculiar mottled variety, capable of taking a high polish, is in particular request, a single tree of this variety having realized as much as £500 for the 22,000 feet of timber it contained. The southern limit of this pine is latitude 37° 30′, so that to Auckland belongs the whole supply. Unfortunately the extra-

vagant rate at which the kauri forests are being despoiled of their timber, points to the probability of this noble tree becoming as extinct as the moa, unless Government intervenes effectively, which they at last seem inclined to do. At some former period the kauri must have covered enormous tracts of country now denuded of all vegetation except poor fern and manuka scrub. Those tracks, notorious for their sterility, are now indicated by large deposits of a fine resin resembling amber, the export of which, valued at £340,000 annually, forms no inconsiderable part of Auckland's commerce. The supply is not likely to fail for sometime, as it is now found that the gum lies in many cases at a considerable depth, and is indeed mingled with the strata of tertiary coal which abounds in the province. The largest kauri tree is said to be that in the valley of the Thames; it measures 46 feet in girth, 130 feet in height, and its lowest branch is 60 feet from the ground.

The area under forest is more than one-fourth of the total area of the colony, but the forest lands are irregularly distributed, the greatest bulk being found in Auckland, Wellington and Westland, whilst a large portion of the hot-lake district, and the Canterbury plains are treeless. The area of forest reserves in 1884 was 594,051 acres, and of plantations 27,075 acres, of which 25,000 acres were in Canterbury. There are about 200 saw-mills in the colony, employing about 5,000 hands, and turning out more than 200 million superficial feet of sawn timber annually. A very large proportion of forests in the North Island is still in the hands of the Maoris. In Auckland the most important tree is kauri; in Southland and Westland, rimu; in Hawke's Bay, totara, and in Taranaki, tawa.

The forests have hitherto been worked on no principle whatever, but simply as mines, and the reckless waste and destruction which has thus been caused is simply appalling. As a consequence, it is calculated that with the present system, or rather want of system, the kauri will be practically worked out within 15 years, and that the supply of totara in the Hawke's Bay district will come to an end even before that period has expired. The forest practically disappears over the areas worked by the saw-mills, as no precaution is taken to preserve it, after all the valuable timber has been extracted; indeed it is usually burnt, and the fire, fed by the débris from the recent fellings, and by the inflammable nature of most of the conifers, generally makes a clean sweep of the entire arboreal vegetation. Mr. Kirk states that in Southland the total area of forest land granted for saw-mill leases during the three years ending the 30th September, 1885, was 5,901 acres, so that, including mills on private land, over 2,000 acres of forest are denuded yearly in this province alone. The forests are often leased at very low rates, and in Canterbury good timber land has been sold for the inadequate sum of £2 per acre.

As an example of the wanton destruction which is going on, Mr. Kirk speaking of the forests on the banks of. Lake Wakatipu says—"Licenses to cut fire-wood amongst the small shrubby growth have been granted and acted upon without the slightest supervision having been exercised.

"As soon as the firewood has been removed, a lighted match is applied to the mass of tops and spray not deemed of sufficient value to defray the cost of removal; the mountain-slope is quickly lighted up with a bright blaze, and any renewal of the natural growth is rendered next to impossible; charred stems of palm-lilies (*Cordyline*), rata, beech and other small trees are all that remain to tell of the luxuriant vegetation which once clothed the slopes. The ashes, however, facilitate a luxuriant growth of groundsel, thistles, piripiri, and other weeds, diversified only by scattered bushes of bush-lawyer, and similar unwelcome growths. The transformation is now complete, the grace and beauty of nature are replaced by rugged untidiness, and one of the most attractive features of the scene destroyed for ever."

In the kauri forests large quantities of timber are yearly destroyed by fires caused by kauri-gum diggers. I myself saw two or three examples of such fires, and although accustomed to fires in Indian jungles, I had never seen anything approaching the devastation caused in these instances.

No trees seemed to escape, but all to be killed outright from the sapling to the giant over 20 feet in girth. This excessive virulence is doubtless due to the quantity of resin in the kauri itself and in the ground at its roots, which makes it very difficult to put out a fire once thoroughly kindled. There can be no doubt but that the present condition of the vast areas covered with bracken and manuka scrub is due to fires, the fern being able to hold its own, and to spread on account of its rhizomes, and the manuka from the protection its seed obtains, enclosed within the hard stony pericarp; indeed, settlers told me that manuka seedlings come up like grass after a bush fire.

The yield per acre in most of the New Zealand forests is very large; thus, in Westland it is estimated at 40,000 superficial feet for red and white pine, whilst near Lake Brunner several acres gave over 80,000 feet. Owing to the kauri occurring in patches, in mixed forests, the average quantity per acre over large areas is probably only 15,000 superficial feet, although in some parts it would run as high as 120,000.

Mr. Kirk's remarks in his report on the forests concerning the timber industry in Auckland are sufficiently interesting to justify their being quoted 'in extenso.' He says—The total value of timber exported from Auckland is returned at £135,952, or more than five times as much as all the rest of the colony put together.

"The large dimensions of the kauri increase the cost of bringing timber to the mill; and in many cases the difficulty is further increased by the broken character of the forest, which renders the con-

struction of tramways almost impossible, so that, speaking in general terms, tramways, invariably used in the south, are rare in the north. The mill is usually erected on the banks of a creek or navigable river, so that the logs may be floated down. If the trees are growing on the banks of a stream, they are felled, cross-cut into suitable lengths, and the logs rolled into the water. When growing at some distance from water it is necessary to construct "rolling roads;" these are broad tracks from 30 feet to 40 feet wide, in which every advantage is taken of the natural incline of the surface, and from which all trees have to be removed, the stumps cut level with the surface, inequalities roughly levelled, and large holes filled up. The logs are forced along these roads by "timber-jacks" until they reach the water. In this way the logs are moved with great ease; the bushmen exhibit a great amount of dexterity in their work, and move the largest logs with a speed which surprises any one who witnesses it for the first time. In no other part of the colony is the jack used for moving timber to any extent—in fact, its use is but rarely required on account of the smaller dimensions of the logs—but I never saw it used with equal dexterity, or with a greater amount of intelligence in England. If the creek contains water of sufficient depth to float the logs, they are simply rafted to the booms at the mill, to be converted as fast as required. It often occurs that the creeks are too shallow to float the logs, so that they must either be conveyed by a tramway to the mill or to deep water, or must wait until a fresh occurs in the stream, unless driven by water stored at high levels by means of dams. The construction of these dams often involves a considerable amount of heavy work and a serious outlay; in some cases side dams are necessary to collect additional water in the small tributary creeks in order to procure a sufficient volume."

The best way for the traveller to see a kauri pine forest, is for him to go by rail from Auckland to Helensville, which is reached in rather less than three hours, and there to hire a horse and ride seven miles to the Bridge Hotel, Kankapakapa, the owners of which are two brothers, who are also employed in working out kauri from an adjacent forest. They were rough but kind, and putting me on a waler mount showed me all over their forests, and a finer sight a forester need never wish to see. The tall kauri pine with its branches and trunk covered with mosses and lichens gave a temperate, not to say arctic, appearance to the upper stage of the forest, whilst below, the tree-ferns and the areca palm reminded one of the tropics. A few ordinary pines were occasionally intermixed, especially kahikatea and rimu, whilst rewarewa and tawa also occurred sparingly. The kauri appears to be a slow-growing tree, and on the section of the trunk of one recently felled, which had a diameter of 3 feet 6 inches, including 3 inches of sapwood, I counted no less than 256 rings. The two brothers showed me a rough but most effective tramway made of kauri sleepers which would last about 10 years. The tram-cars were very strongly built, with wheels 6 inches wide running on the sleepers without a rail or groove,

and the axle of the wheels was so arranged, that it could shift up and down following the unevenness of the road, a key right through having been found to be a mistake. Logs from 70 to 80 feet long and from 20 to 30 tons in weight could be carried on a couple of trams, the logs resting on iron bolsters, and being kept in position by a chain and an union screw. Full particulars concerning the construction of this tramway would, I have no doubt, be willing supplied by Messrs. Jagger and Parker, Timber Merchants, Auckland, New Zealand.

Drifting sands similar to the dunes of Gascony are common along parts of the coast, as the Waikato Heads and the Kaipari sand-hills, and although Mr. Kirk made suggestions as long ago as 1873, for arresting the process of destruction going on in so many localities, by planting operations, it is believed that little or nothing has been done in the matter up to date. The magnitude of the evil to be remedied is admitted by all who have paid the slightest attention to the subject. In several localities the natives are compelled, year by year, to abandon their cultivation as the sand-wave advances, and settlers are helpless witnesses of the invasion of their paddocks by the same cause. Fences, large trees and patches of bush, have been overwhelmed within the memory of settlers of comparatively recent standing.

It is pleasing to note, however, that Government are at last awakening to the importance of an industry, whose exports amount to half a million yearly including gum, in addition to the enormous local consumption of timber. In September 1885 an Act was passed to provide for the reservation of State Forests in New Zealand and for the control and management thereof. This Act empowers the Governor in Council to set apart land for State Forests and to make regulations for such forests on the following subjects amongst others :—(1), Duties of forest officers and subordinates ; (2), Prevention of destruction of growing timber ; (3), Terms of forest licenses ; (4), Protection of forests against fire ; (5), Construction and use of railways, tramways and other roads in the forest. The Governor in Council may impose reasonable penalties not exceeding £50 for any one offence, the penalty imposed being recoverable by a civil suit. Clause 26 of the Act is rather instructive, as, doubtless owing to the difficulty in proving forest offences, the burden of proof is thrown on the accused. It reads as follows :—

"Any person found within any State forest, or on any road in its vicinity, and having in his possession any tree or part of a tree, who, on being thereunto required by any Conservator of forests or other officer under this Act, or by any person having a right to cut wood on any such forest or part thereof, or by any one acting on behalf of such person, refuses to give a satisfactory account of the manner in which he became possessed of any such tree or part of a tree may be taken by the party interrogating him before any Justice of the Peace, and if such person does not satisfy the Justice that he came lawfully

by the said tree or part of a tree, he shall on conviction by such Justice forfeit and pay over and above the value of such tree or part of a tree so found any sum not exceeding £5."

A similar maximum of fine in the following case seems to be very inadequate :—

"Any person marking any timber with any brand not belonging to him, or branding any timber belonging to any other person with any brand other than the brand of the owner thereof, shall be guilty of an offence, and shall be liable to a penalty not exceeding £5 for every such offence."

It is doubtful whether any person would be deterred from committing such an offence, by this ridiculously low penalty, as a single log would often be worth more than the maximum fine. In the Indian Act such an offence is punishable with two years imprisonment as well as fine. The punishments in the New Zealand Act are all remarkably light, imprisonment not being mentioned, and perhaps the only punishment which may be regarded as heavy is the poundage fee charged on cattle which have trespassed in a forest reserve. The fee is 5*s*. per head for any kind of animal, there being no graduated scale as in our Indian Act.

The first result of the Act was the appointment of Mr. Kirk as Chief Conservator in December 1885, and reports on the present state of the forests, and on bark and secondary forest produce have been submitted by him to the Assembly, whilst he is engaged in preparing a popular descriptive work on the timber-trees of the colony, under the title of "The Forest Flora of New Zealand."

It is proposed to organise a combined School of Forestry, Pomology, and Agriculture at Whangarei ; Pomology being included, as fruit-culture is fast becoming one of the most important industries of the colony, whilst the fruit trees are particularly liable to disease. The organisation proposed by Mr. Kirk is as follows :—

"1. THE STAFF.—TEACHING. *A General Manager*, who should have sole charge of the institution, subject in all respects to the approval of the Commissioner of Forests, and should be held responsible for the maintenance of discipline and the efficient working of the school. He must be thoroughly acquainted with the theory and practice of agriculture, and be able to lecture on the subject. He should have had experience in the management of a teaching-staff and in the control of students.

"2. *Biological Lecturer*.—The biological lecturer must have a theoretical and practical knowledge of botany and zoology, with a detailed knowledge of ordinary forest- and fruit-trees, agricultural plants, especially of grasses and forage-plants, both Native and introduced. It would be an additional advantage for him to possess a knowledge of the diseases of plants, whether constitutional or parasitic, more especially those of a fungoid character, and with the chief external and internal parasites of farm-animals. He would be re-

quired to take charge of the biological laboratory and museum, also of a portion of the experimental grounds, and to carry out such experiments as may from time to time be deemed advisable.

"3. *The Chemical Lecturer* must be well acquainted with inorganic and organic chemistry, more especially as applied to the products of the forest, the orchard, and the farm. He will be required to lecture on chemistry and physics; to take charge of the chemical laboratory, and carry out such inquiries and experiments as may be required.

"4. *The Lecturer on Forestry and Pomology* must be acquainted with the theory and practice of these branches, and competent to give directions to the forester. He should take charge of the plantations and orchard, also the larger portion of the nurseries and experimental grounds.

"5. *The Mathematical Lecturer* will be required to teach geometry and trigonometry as applied to land-surveying; levelling, mechanics, and hydrostatics; also book-keeping for the forest, farm, and orchard. The practice of surveying and levelling must be taught in the field.

"*A Porter*, whose business it should be to keep the lecture-hall, class-rooms, laboratories, library, lecturer's room, and offices in proper order, and to light fires, lamps, &c.

"THE STAFF.—THE PLANTATION, ORCHARD, AND FARM.—*A Gardener and Forester* who must also be well acquainted with fruit-growing. He must be capable of carrying out experiments and instructing students in the plantations and orchards.

"*A Dairyman* to take charge of the dairy and the general supervision of the stock.

"When the School is well under way it might be found practicable to give a limited amount of instruction in carpentry and smith's work as applied to farm and forest purposes.

"ROUGH STATEMENT OF ACCOMMODATION REQUIRED IN THE SCHOOL-BUILDINGS, HOUSES FOR LECTURERS, &C.—Residence for Manager (eight rooms); day-rooms and dormitories for resident students, dining-hall for students, kitchen, lecture-hall, two class-rooms, biological laboratory and museum, chemical laboratory, reading-room and *library, manager's office, lecturer's room, porter's room, &c.*; two houses for lecturers (six rooms), two houses for lecturers (five rooms), three cottages—for forester, farm-manager, and dairyman (one six rooms, two five rooms), garden-shed, tool-house, and packing-room. I believe the above might be erected for £4,000; but it is desirable that a professional estimate should be obtained.

"FARM-BUILDINGS, &C.—Stabling for horses, milking-shed, cattle-yards, &c., piggeries, implement-shed, dairy and cheese-room, superintendent's office and seed-room, granary.

"In compliance with the suggestion of the Commissioner of State Forests, the salaries for lecturers on forestry and on mathematics are omitted in the following estimate for the first year, their work being discharged by the biological and chemical lecturers respectively; Manager, with house and profit on board of students, £500; biological lecturer, with house, to lecture also on forestry and fruit-culture, £300; chemical lecturer, with house, to lecture also on mathematics, £250; forester and gardener, with house, £125; dairyman, £100; porter, £80; total, £1,355. The salaries of the lecturer are too low

for properly-qualified men; but this point will be referred to elsewhere. It is assumed that a superintendent of farm-labour may be dispensed with for the first year."

The following remarks show that it is not intended to pamper the student by too much attention, thus rendering him discontended with his future rough life :—

"The annual cost of maintenance will be greatly increased if it be determined to provide the students with any great amount of luxury. In my opinion each student should be required to keep his bed-room and study in proper order, to clean his own boots, to wait at table in due course, and discharge other duties of a kindred nature. Discipline of this kind would involve no real hardship, and would foster a healthy spirit of self-help. Settlers of restricted means entertain the idea that the amount of attention sometimes paid to students at agricultural schools tends to render them dissatisfied with their homes, and unfits them for the plain homeliness of a settler's life. Any course tending to produce this feeling should be avoided as far as possible. If a large staff of waiters and attendants has to be maintained the fees must of necessity be high, which would prevent struggling settlers from taking advantage of the facilities afforded by the school. If, on the other hand, the students are required to wait upon themselves, as the majority would have to do in their own homes, the fees need not be higher than would be sufficient to cover the cost of board, the student's labour being considered to some extent an equivalent for the cost of teaching and the use of apparatus."

It is much to be regretted that with all these well-meaning efforts to preserve their forests, the colonists have no one who really understands what forestry is, or how extensive forest areas should be managed. The only idea, which is essentially that of a nurseryman, appears to be to cut down so many acres of indigenous forest every year, and to replant the worked out area with introduced species, such as eucalypts and wattles. It also seems to be thought that any one can lecture on forestry, thus £300 a year is to be provided for a biological lecturer who is also to lecture on forestry and fruit-culture, but where such a highly-qualified gentleman is to be obtained for the pay, is not apparent. It is not clear how forestry can be started on a sound basis, unless the colony first of all obtains the services of some one who has been trained in the principles of forestry as taught on the continent of Europe, or at the newly-organized Forest School at Cooper's Hill, and it would be a step in the right direction if two or three young colonists were given a training by the State at Cooper's Hill, so that in this way the services of trained foresters thoroughly acquainted with the colony would be obtained.

TAU-THA.

A WORKING SCHEME

IAU-THA.

A WORKING SCHEME.

AFTER perusing with interest, in the "Forester" for July last, the opening remarks of the review of the Madras Forest Admi-

nistration Report for 1884-85, I was checked at the third page by an account of a working scheme for the Coonoor Peak "Old Forest Plantation," on the Nilgiris, which is there mentioned and quoted from.

In the first place it seems to be quite a mistake to attribute the scheme to Mr. Gass. For it is stated in the report (Appendix A., Northern Division) that although a scheme *was* prepared in 1883 by Mr. Gass, it was judged expedient the next year to alter it, and from what follows that officer does not appear to be responsible in any way for the present scheme.

In Chapter III., under "Working Plans," the operations of the year in this plantation are mentioned, and Appendix A. is referred to as giving "the revised working scheme." Appendix A. must, therefore, be taken as containing the provisions for the management of the plantation which the officer in charge will have to depend upon for his guidance.

It appears that a final sub-division into blocks and compartments was made in 1884, and that the treatment was to be "high forest" from that moment. It is considered probable that a 60 years' rotation will suffice, to be divided into six periods ('five' is presumably a mere slip) of 10 years each; at any rate there is to be a "rotation of 10 years thinnings." After this comes only the description of blocks and compartments before the "plan of working for coppice." And here it may be observed that, as is remarked in the review, no clear account of the standing crop, the fundamental point in a working scheme, is given. Still it need not have been assumed in the review that it is composed of *Acacia Melanoxylon,* for from the mention of blue-gum when considering the high forest rotation it may be inferred that the stock consists fundamentally of that tree, and besides only two compartments (area 10·4 acres) are mentioned as containing acacia.

To return. Beyond arranging for 10 year periods and a probable 60 years' rotation, no provision for working has so far been made. Consequently the 'plan of working for coppice' must be part of the scheme for which high forest has been taken as the method of treatment.

Now come the 'general prescriptions' (for coppice rotation), the results of which require consideration. In the first rotation 400 trees per acre are to be left as standards. If 600 so much the better. Also shelter belts at least three trees thick along the edges of compartments and roads. Now it is stated in Mr. Hutchins' report on the measurement of the growth of Australian trees on the Nilgiris that the plantation, or at least 200 acres of it, was originally planted 9′ × 9′, and consequently contained 537 trees per acre (if there were no failures). Suppose, however, 450 trees per acre were left (to leave 600 being impossible), the result is a coppice-felling which is really a thinning out of one-sixth of a uniform and perfectly distributed stock. That is not the common idea of a coppice-felling.

But there are to be shelter belts left. At the lowest computation, taking an average compartment of 5 acres and supposing it to be nearly square, the mere belt round the edge, since three trees 9 feet apart will take up a breadth of 9 yards, will occupy about 1·1 acre, or 22 per cent. out of the five. If this is counted in and the trees it contains as part of the 2,250 (at 450 per acre) to be left, it will bring the thinning up to about 20 per cent., but the plantation at the end of the first period will be covered by a network of bands 18 yards broad occupying 22 per cent. of its area (in reality more, on account of roads and the irregular shape of the compartments) of trees standing 9′ × 9′ untouched since they were planted and of an age equal to one-third of the rotation considered likely to suit for high forest.

In the second rotation the standards are to be reduced to 300 and gradually to 40 or 60 by the end of the sixth period, but whether the belt is to be touched or to what extent is not stated. No doubt there will be a fully stocked high forest of big timber at the end, but there evidently exists a fully stocked high forest (though not of big timber) already, and so there will be continuously between this and the end of the rotation.

What then is the meaning of these "coppice rotations" and a belt which should protect coppice growing under a fully stocked high forest containing only 20 per cent. trees less than the belt itself? Fortunately it is mentioned that the scheme is liable to revision at any time, the contemplated reason which may necessitate a revision being a possible largely increased demand for fuel, in which case a return to simple coppice is felt to be best. But why was the method of treatment ever changed? If demand for fuel largely increases the reasons for change will be financial: but in deciding on high forest the same point, with respect to timber, is not considered. In fact no reason for adopting the method is given at all, but the argument passes abruptly from the necessity of changing the original plan on account of damage by storms, for which too a good remedy is proposed, *viz.*, re-arrangement of the compartments, to the un-motived 'determination' to change to high forest.

As to the concluding para. of the Appendix its meaning is hopelessly obscure. Which are the compartments under reproduction every third and sixth years? What is the nature of the reproduction? Is the coppice to be thinned or the standards? And how are blanks in a coppice growing under thick and fully stocked high forest to be recognized?

It is possible that this scheme represents a practical management to the person who compiled it, but a working scheme ought to be reasonably intelligible at least in its broader provisions to an outsider. It may be a fair attempt to provide for the management of an interesting plantation, and it is hoped that some explanation of it will be given in the "Forester," but it is a pity the Conservator did not consider and revise it before giving it his sanction by printing it in the annual report.

P. & P.

NURSERIES FOR RUBBER, *(FICUS ELASTICA.)*

Seed-beds should be prepared where the soil is neither too moist nor too dry. The ground should be well hoed to the depth of 2 feet, and the earth exposed to the sun for a day or two, and then hoed again. When the soil is soft, raised beds should be prepared a good foot above the ordinary level. The beds at the Charduar plantation in Darrang were, if rightly remembered, 40 feet by 3 feet.

Charcoal should then be powdered finely and mixed with the upper portion of the soil. The whole of the upper surface of the bed should be fenced in by reeds, sufficiently high to keep the earth from falling away and carrying seed with it, when being watered, &c.

The next step is to build a shade over the beds. The shade should be sloping, being 6½ feet high on one side and 4½ feet on the other, the higher side facing the north, for the length of the beds should run east and west. This shade should be light and is easily constructed, the posts being first fixed with a few purlins, and then light frames of thatching grass tied firmly on to them. Great care must be taken that this roof does not leak, and that the beds are far enough apart to ensure the drip from neighbouring roofs against falling into them.

It is now time to sow the seed. This should never be done with the whole fruit, which should be broken between the hands and pressed frequently through a fine sieve. It should then be thrown broadcast over the prepared beds, with an extremely light covering of earth. About five seers of seed (not broken) are necessary for beds 40 feet by 3 feet. The best time to sow is early in April, though the seed will germinate no matter when sown. It was observed that seedlings were stronger and germination more profuse from April's sowings.

The beds should then be lightly watered for the first few days, but not afterwards till germination, unless it is exceptionally dry. After germination, light watering is necessary, which is increased as the seedlings grow stronger.

When the seedlings begin to look strong, the shades should be removed, but very gradually indeed, or the young seedlings will be scorched. The shades should be moveable, so that they may be replaced during the hottest portion of the day.

On attaining a height of two inches, the seedlings are fit for pricking out into beds, which should be specially prepared for them, but not raised. These beds are 2 feet wide, and seedlings are pricked out 18 inches apart in a double row, at the Charduar plantation.

The transplanting beds must be kept very clear of jungle till the seedlings are strong enough to keep it down. They require no other care, except that in planting them out again on their final resting places, the roots should not be injured. Planting

out on mounds is advisable; just when the rains commence or are about to close being the best time.

Before germination of seed and immediately after it, moss used to grow on the seed-beds and do grave damage at Charduar, and this was only removed by deep hoeing in the first instance. Innumerable grubs also did immense harm subsequent to germination, and here the removal of shades and watering with tobacco mixture, &c., was beneficial.

JUNGLI.

ABYSSINIAN TUBE WELLS IN TARAI FORESTS.

THE forests of Eastern Kumaon outside the hills are noted for their extreme unhealthiness, attributable partly to the impurity of the surface water, which in the absence of wells is used for drinking purposes. Although one or two masonry wells have been sunk in this part of the Division, the work is rendered costly and difficult on account of the absence of skilled labour of any description.

It was, therefore, proposed last year to experiment with one of Norton's tube wells, with a view of both speedily and cheaply obtaining pure water free from surface impurities.

The actual cost of 30 feet of tubing and a pillar pump necessary for *each* well amounted to £3 14*s*., but the necessary tools for sinking an indefinite number of wells were also procurd at an outlay of £13 9*s*., freight, &c., to India came to £2 2*s*., and there were the usual rail and agent's charges. It is probable that the articles now required, *viz*., piping and pillar pumps, can be cheaply procured from the local workshops, and that Rs. 50 or Rs. 60 would cover the cost of each well sunk to a depth not greater than 30 or 40 feet.

Employing four coolies in the experimental sinking, water was reached at 20 feet in a bed of very fine sand. This speedily choked up both tubes and pump, and all the tubes had to be withdrawn. After substituting a gauze covered borer for the one with large perforations the tubes were again sunk to 30 feet, but here the water-bearing soil had been passed. The tubes were then raised 5 feet, and a continuous flow of good water followed the application of the pump. All that remained was to embed the base of the pump in masonry.

In spite of various contretemps due to inexperience, the work was completed in one day; in other circumstances, a few hours should be sufficient.

The system is recommended to Forest officers stationed in districts where water is scarce or bad, and where the subsoil is free from large boulders or rock.

If water when reached does not rise to within 26 feet from the surface the well must, however, be fitted with a force pump, which will make the work more expensive.

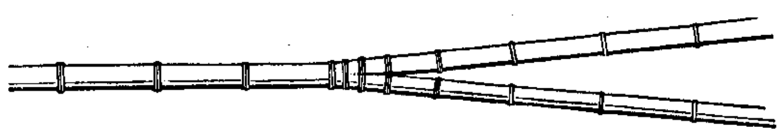
S. EARDLEY WILMOT.

BAMBOO FORKING.

I SEE a para. going the round about a bamboo having bifurcated, and as there appears to be no attempt at explanation how the phenomena is caused, I send you the following.

Some 14 years ago, while clearing a path, I came across a blossom of the kugra (*Saccharum spontanum*) that forked equally, and carried two spikes of blossom, the conversation turned on "sports," or freaks of nature, and one man said there was a forked bamboo in the village.

This I sent for and found it was true. The total length was about 30 feet, and the fork was some 10 feet up, and each bamboo was equal in size, and after forking grew as usual, except that the nodes began closer together at first, (as when growing from the ground,) and became more distant gradually as per sketch.



The independent explanation offered by two men was to the same effect, *i.e.*, that while growing, the apex of the bamboo (within the sheaths) had been pierced by one of the bamboo bugs, so common, and that it had injured the centre of axis only, and the sides grew up, and each formed a distinct axis thence.

SIBSAGAR,
12th September, 1886.

S. E. PEAL.

JARDINAGE.

IT has been suggested that the method of exploitation known as jardinage is the most generally applicable to our forests in India. This method entails the felling of trees scattered over the whole forest, the entire area being in this way worked over, either every year, or in a very limited number of years. The whole forest is continually under regeneration and contains growth of all ages.

The question I wish to ask is whether a working plan, based on this method, can arrange for grazing, and if so, how? Of course the amount of damage done by grazing depends much on the kind of forest, its situation, &c. In a pure, or nearly pure, sál forest, for instance, worked on the jardinage method, in which the grazing is very light and there is plenty of other food for the cattle, the damage done would be less than in the cases of some other forests, such as our hill-forests of oaks, maples, &c., but the question of damage is merely one of degree.

Would some of your readers kindly give me advice, and tell me whether for a forest in which grazing has to be allowed it is possible to apply the jardinage method, and if so, how?

If I am right in believing, grazing to be incompatible with the application of this method, it seems to me that we cannot adopt this method for the generality of our forests.

9th November, 1886. E. G. CHESTER.

OLD Nancy men should know that the first part of Reuss's Cours d'aménagement is now lithographed, and obtainable from the Agent Comptable at the Ecole Forestière on payment of 5·50 francs. I think it is good, and well worth buying.

F. B.